

PHONOLOGICAL ANALYSIS OF THE SPEECH OF CHILDREN WITH  
CLEFT PALATE

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Pathology

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DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Arts in Speech Pathology to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.



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24th day of December, 1985.

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ABSTRACT

This study concerns the description of speech sound production errors of cleft palate children in terms of phonological processes. Eight four-year old children with repaired clefts of the palate were studied. Speech samples were obtained from an object naming task and a structured connected speech task. Results were analysed in terms of group and individual subject performance. In the group analysis, eleven phonological processes were identified. These comprised mainly substitution processes but syllable structure processes and assimilation processes were observed. Some of these processes were considered as being typical of children with normally developing phonology, others suggested patterns of phonological delay, and still others, patterns of phonological deviance. Noteworthy was the heterogeneity of process occurrence; no two subjects showed the same sets of phonological processes. Some processes, were however, present in all eight subjects. In addition to phonological process analysis, contrastive analyses were performed on the speech samples for each subject. The results of individual analyses indicated that the subjects showed a reduction in their systems of phonemic contrasts as they were unable to make meaning differences between some classes of sounds at the level of speech output. Diagnostic and therapeutic implications of the findings of the study were considered.



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CHAPTER 1  
INTRODUCTION

The development of good communication skills is a critical consideration in the habilitation of children with cleft palate. For many children with cleft palate surgical management of the cleft is followed by normal development of speech. A substantial percentage of cleft palate children, however, fail to develop satisfactory speech and require further treatment.

Historically, disordered speech production in cleft palate children has been primarily related to structural inadequacies. It is widely accepted that velopharyngeal incompetence, resulting in the inability to impound intra-oral air pressure, is the primary causal factor of disordered speech production. Additional factors such as dental and occlusal anomalies, and the increased risk of middle ear pathology and hearing loss may also influence the production of normal speech.

However, structural factors alone cannot logically account for all errors in speech production in children with cleft palate. Factors which affect learning may play an equally important role in the acquisition of speech. Moller, Kittleson and Broen (1983) summarise the current approach cogently when they state:

When children with no physical deviations have articulation problems, we assume they are the product of faulty learning. When clefts are present, we often behave as though physical factors are the sole causes of articulation problems (p. 5).

It must be appreciated that apart from having a deviant speech mechanism, the developing cleft palate child must learn the phonological system of his ambient language community. As such, he is subject to the same physiological, perceptual, cognitive and maturational constraints as are non-cleft palate children (McWilliams, Morris and Shelton, 1984).

Survey of the literature dealing with communication problems of cleft palate children reveals that a great deal of attention has been given to the structural and physiological foundations of speech production (McWilliams, 1954; Moll, 1964; Shelton, Brooks and Youngstrom, 1965; Spriestersbach and Powers, 1959; Subtelny and Subtelny, 1959, among others). Researchers in cleft palate have paid limited attention to the description of the phonological aspects of speech sound production, i.e. to the patterns of sound usage in language. However, several authors have alluded, at least indirectly, to the possibility that children with cleft palate may display patterns of phonological development which are different from those of non-structurally impaired children (Bzoch, 1965; Edwards, 1980; Moll, 1968; Shames and Rubin, 1979).

Researchers in phonology, on the other hand, have seldom examined the errors of cleft palate children in a phonological context. Instead, the principles of phonological analysis have, in the main, been applied to children with functional articulation disorders. Only in the last decade, have attempts been made to examine phonological development in other clinical populations, e.g. hearing impaired (Dodd, 1976) and mentally retarded children (Stoel-Gammon, 1980); and it is only in the past three years that systematic studies have been conducted to describe the phonological patterns of cleft palate children (Hodson, Chin, Redmond and Simpson, 1983; Lynch, Fox and Brookshire, 1983; Moller et al., 1983). Other clinical phonologists do mention cleft palate, but usually in passing, to illustrate the difference between phonetic and phonological disorders (Grunwell, 1983a; Stenberg and Kwiatkowski, 1980).

In the past, assessment and remediation of disordered speech in cleft palate children have largely reflected the traditional approach used for children with functional articulation disorders i.e. children who have no identifiable organic cause for their speech disorder. Speech assessment has focused predominantly on the description of errors of

articulation at a segmental level. In the same vein, remediation procedures have emphasized correct production, usually in a sound-by-sound approach. Typically, as in therapy for functional articulation disorders, a target sound is selected for reasons such as stimulability, developmental sequence, visibility or inconsistently correct production and then correct production is taught first in initial, then medial and then final word position. When the child is able to produce the target sound in words and phrases, the process is repeated for the following error sound. While this traditional approach has effectively served cleft palate children with few errors of articulation, it has been less effective with children who have multiple errors (Bzoch, 1979; McWilliams et al., 1984).

In the last decade, the increased knowledge of normal phonological development and growing dissatisfaction with the traditional approach to therapy for children with multiple articulation errors have led speech pathologists to apply the principles of phonological theory to the analysis of disordered speech production. Such descriptions have employed the constructs of distinctive features (McReynolds and Huston, 1971), phonological rules (Compton, 1976) and phonological processes (Ingram, 1976) in order to relate the child's productions to the standard adult model. This phonological approach to the description of speech production disorders differs fundamentally from the traditional approach in that the former considers patterns of errors and the systematic nature of speech production whereas the latter considers individual segments as independent units.

Despite growing recognition of the need for the description of patterns of errors, only a few attempts have been made to bring the power of current assessment techniques to bear on the analysis of the speech of children with cleft palate as noted by McWilliams, et al. (1984) and Moller et al. (1983). To the present writer's knowledge, only three recently published studies mentioned above, i.e. Hodson et

al. (1983), Lynch et al. (1983) and Moller et al., (1983) have applied phonological analysis to the description of speech disorders in cleft palate children. These studies have utilised single cases, limiting the generalisability of their findings.

The present study was motivated by the paucity of knowledge regarding phonological patterns in children with cleft palate. It is hoped that understanding of the phonological patterns in cleft palate children in these terms may aid in formulating appropriate treatment aims.

The theoretical framework adopted in the present study is that speech sound production errors in children with cleft palate are rule governed and systematic in nature, a view supported by Grunwell (1983a) and Ingram (1976) as well as by observations from the writer's clinical experience. According to Ingram (1976):

virtually every study that has undertaken the linguistic analysis of a child with a phonological disability has revealed system in the child's speech. This is true both for children with a general disorder and those with specific syndromes, for example, hard of hearing, cleft palate, etc. (p. 99).

Furthermore, it is the writer's contention that the error patterns observed in cleft palate children seem to reflect impaired ability to signal the phonological contrasts of their language on a productive level. This study aims to test this assumption by examining these patterns in greater detail through the application of phonological process analysis.

The construct of a phonological process is derived from Stampe's theory of natural phonology (1969). Phonological processes are seen as simplification strategies "which operate on the adult input to produce the child's speech pattern" (Ingram, 1976, p. 49). For purposes of the present study, a phonological process is defined as a systematic sound change which merges the phonological contrast of a class of sounds or sound sequences. Discussion of the controversy surrounding the definition of a phonological process is elaborated on



in Chapter 3.

In contrast to the traditional approach to the description of speech sound production disorders, the phonological process approach takes account of both the syllable structure as well as the segmental levels of speech production (Ingram, 1976). It provides the clinician or observer with a useful tool for the identification and description of patterns in a given child's speech production and offers valuable insights for remediation planning (Grunwell, 1982; Hodson and Paden, 1983). Since recent research has adopted this framework for the description of normal phonological development, "the processes found in disordered data are easily compared with what are taken to be normal processes" (Grunwell, 1981, p. 55).

At the outset, it is important to state that the present study is offered from a clinical perspective. It is not the purpose of this investigation to evaluate or indeed examine a particular phonological theory as applied to cleft palate. Instead, the purpose is to examine whether disordered speech production of cleft palate children can be described in terms of phonological processes. Furthermore, although the construct of phonological process is central to the theory of natural phonology, its application in the present research differs from that stated in Stampe's (1969) theoretical account. Stampe assumes that the underlying representations of the child are equivalent to that of the adult; in the present study, no claims are made about underlying representations or about phonemic perception. Thus, phonological processes are used simply as descriptions of observed deficient patterns which operate at the physical phonetic level of speech production, i.e. at the level of "physical speech production and/or the resulting acoustic signal" (Foster, Riley and Parker, 1985, p. 295). The writer adopts the view of Hodson and Paden (1983) who acknowledge that:

... a great deal more research is needed on how children perceive adult speech, how they internally organize the acoustic signals they perceive and how their surface forms

relate to their internal organization of these signals before we can make positive statements concerning the cause of a child's phonological system (p. 8).

The purposes of the present study are to describe the speech sound production disorders of a group of children with cleft palate within the framework of phonological process analysis and to explore the applicability of this framework of analysis to disordered speech production in cleft palate children. It is hoped that the findings of this study may aid in the more effective diagnosis and remediation of speech disorders in children with cleft palate.

#### I. TERMS USED IN THE STUDY

At the outset it is necessary to define some of the terms as they are used in the study.

The phrase "speech sound production disorder" is used deliberately and in preference to "articulation disorder" or "phonological impairment" as it makes no claim regarding the etiological basis of the disorder. As used in this context, "speech sound production" refers to the phonetic output of the consonants of English, i.e. the physical phonetic level referred to on p. 5, and does not refer to phonemic organisation.

In this report, "articulation" refers to the activity of the structures of the oral mechanism necessary to produce a particular sound; it does not therefore denote "articulation" in relation to "phonology" as has been used elsewhere (Shelton and McReynolds, 1979; Shriberg and Kwiatkowski, 1982a).

Cleft palate refers to the congenital condition affecting the normal development of the hard and soft palate. Although it is recognised that cleft lip and palate frequently co-occur, for the sake of brevity the term "cleft palate" is used in preference to "cleft lip and/or palate". In addition, the study makes frequent reference to "cleft palate children". This term does not deny the additional features which characterise these children, but is used as such for

convenience.

A complete cleft refers to a cleft which extends from the external lip posteriorly through the alveolar arch and the hard and soft palates (McWilliams et al., 1984).

An isolated or incomplete cleft refers to a cleft which occurs without lip involvement. It may include all of the hard palate posterior to the incisive foramen or only a small portion of the posterior border of the soft palate; or it may be somewhere between the two extremes (McWilliams et al., 1984).

## II. DESCRIPTION OF CHAPTERS

The discussion presented in Chapters 2 and 3 is intended to provide background information of the major areas covered in the present study and to serve as a framework for the interpretation of its results. Chapter 2 describes the features of and the factors contributing to disordered speech sound production in preschool children with cleft palate.

Chapter 3 outlines the controversy surrounding the status of articulation versus phonological disorders. This chapter describes the application of phonological theory to the clinical management of children with speech sound production disorders in general, and to cleft palate children in particular.

Chapter 4 highlights the major methodological issues relating to data collection and data analysis for the study.

Chapter 5 concerns the design of the study, the description of the subjects and the procedures followed.

Chapters 6 and 7 detail the results of the study and the discussion thereof. In Chapter 6, the results of the phonological process analyses are presented. These results are presented in two sub-sections. In the first, group trends are described. The second sub-

section details the phonological processes observed and the manner in which they were applied by the subjects.

Chapter 7 contains the findings of the phonological analysis of the speech samples of individual subjects.

Chapter 8 presents a general discussion which includes a summary of the major findings of the study. The findings are interpreted in terms of previous research in the fields of cleft palate and clinical phonology.

Chapter 9 forms the final chapter of this report and contains the concluding comments. Clinical implications of the findings are discussed and indications for future research are suggested.

CHAPTER 2ETIOLOGICAL FACTORS RELATED TO SPEECH SOUND PRODUCTION ERRORS  
IN CHILDREN WITH CLEFT PALATE

A major concern of the speech pathologist involved in the management of children with cleft palate is the differential diagnosis of the causes of disordered speech sound production (Bzoch, 1979). The etiology of speech problems in cleft palate can be considered in terms of those factors which relate directly to the structural palatal deficiency and those which are associated with, but are not directly part of the cleft palate. This chapter deals with those factors or variables which are contributory to speech sound production disorders in children with cleft palate. As a framework for this discussion, the characteristic speech sound production errors frequently observed in cleft palate children are briefly presented.

I. FEATURES OF DISORDERED SPEECH SOUND PRODUCTION IN PRESCHOOL  
CLEFT PALATE CHILDREN

In the past, several descriptions have been published characterising disordered speech sound production in children with cleft palate (Bzoch, 1965; 1979; Fletcher, 1978; Moll, 1968; McWilliams et al., 1984; Priestersbach, 1965; Priestersbach, Darley and Rouse, 1956; Van Demark, Morris and Vandelaar, 1979; among others). In the main, these descriptions are based on group trends rather than individual cases. Furthermore, it is not uncommon, among these publications, to find reference to "cleft palate speech", a "shorthand" phrase used to denote speech phenomena such as audible nasal emission, hypernasality and glottal and pharyngeal articulations. However, in recent years this phrase has fallen into disrepute. Clinicians and researchers alike have frequently observed the presence of additional errors of speech production, apart from those mentioned above. Therefore, it

may be potentially hazardous to appropriate diagnosis and therapy if only the errors encompassed by "cleft palate speech" are evaluated or treated. In addition, the variety of errors of speech sound production exist in different combinations within and among cleft palate children. According to Morris (1979):

So heterogeneous is the cleft palate population in variables relating to communication skills that it is difficult, if not downright impossible to describe meaningfully "cleft palate speech" (p. 193)

*Despite the heterogeneity, however, certain features of disordered speech production in cleft palate children have been described often enough for a common set of features to emerge. These include the following:*

A. Audible nasal emission

Audible nasal emission occurs when air pressure normally directed through the mouth, escapes through the nose, becomes turbulent and generates noise (McWilliams et al., 1984; Morris, 1979). Consonants, usually pressure consonants (stops, fricatives and affricates) are affected by audible nasal emission. In most cases, the target consonant retains its distinctive features and is recognisable as such. In some cases, however, audible nasal emission may be so severe that the phonemic characteristic of the target sound is lost and oral stops may be perceived as nasal consonants e.g. [b] may be perceived as [m].

B. Hypernasality or hypernasal resonance

In contrast to audible nasal emission which affects pressure consonants, hypernasal resonance affects vowels and syllabic consonants. In hypernasality, sound energy during the production of a vowel is resonated through the nasal cavity (Wells, 1971). Hypernasality is allophonic in English and does not usually alter the phonemic characteristics of the target sound (Shriberg and Kent, 1982). In the present study, occurrences of hypernasality are transcribed, but are not considered in depth, since the primary focus

concerns the phonological rather than the phonetic aspects of speech sound production.

C. Hyponasality or denasality

Hyponasality, less common than hypernasality, is characterised by an absence of normal nasal resonance usually present in vowels and nasal consonants (Bzoch, 1979). While hyponasality is allophonic for the production of vowels, in severe cases it may alter the phonemic contrasts in nasal consonants e.g. [n] may be produced as [d].

D. Gross pharyngeal or laryngeal compensatory articulations

Glottal stops and pharyngeal fricatives are compensatory articulations which replace oral stops and fricatives respectively, and usually occur in the presence of velopharyngeal incompetence. Recently, Trost (1981) has added three other frequently occurring compensatory articulations to the classic glottal stop or pharyngeal fricative. These include voiced and voiceless pharyngeal stops, voiced and voiceless mid-dorsum palatal stops and posterior nasal fricatives (often referred to as a nasal snort).

E. Oral distortions

Apart from the compensatory errors mentioned in (D) above, a variety of distortions of oral consonants have been described, such as laterally released /s/ giving rise to [ɬ], or incorrect place or manner of production of sibilant consonants (Fletcher, 1978).

F. Developmental errors common in the speech of normally developing non-cleft children

Several researchers have reported that children with cleft palate commonly demonstrate errors of speech sound production which are similar to those observed in children without cleft palate. These include incorrect production of liquids, interdental fricatives, and consonant clusters (Bzoch, 1965; Van Demark, 1964; Van Demark et al., 1979).

In summary, children with cleft palate may display certain errors of speech sound production associated with the structural anomaly, whereas other errors may be typical of the speech of children without cleft palate. Until now, the features of disordered speech have been described without reference to their etiological bases. In the next section, the wide range of factors underlying these errors of production are explored.

## II. FACTORS CONTRIBUTING TO DISORDERED SPEECH SOUND PRODUCTION IN CHILDREN WITH CLEFT PALATE

Any attempt to explain disordered speech production cannot only be confined to anatomical or physiological correlates, but must account for the developmental factors which contribute to speech sound acquisition in all children, with and without cleft palate.

The major contributory factors to disordered speech sound production in cleft palate children is graphically conceptualised in Fig 1. This explanatory model is adapted from the work of Shriberg and Kwiatkowski (1982a) who used a similar framework to consider the major etiological correlates in phonologically disordered children. This model was felt to be appropriate as it takes account of multiple causality of the speech problems and highlights the influence of oral mechanism characteristics, developmental factors, and psychosocial factors on the production of speech.



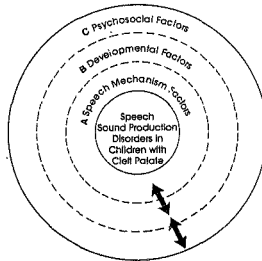


Fig. 1: Major contributory factors to disordered speech sound production in children with cleft palate (adapted from Shriberg and Kwiatkowski, 1982a)

The innermost circle of the model represents the speech sound production disorder of a child with a cleft palate. The next three circles in turn reflect the influence of speech mechanism, developmental and psychosocial factors on speech sound production. The combination of the three concentric circles captures the universe of predominant factors affecting speech sound production in children with cleft palate. The order of presentation of the three circles is deliberate and reflects a progression from those factors which are basic or central to the disorder (mechanism factors) to those which are peripherally or less directly related (psychosocial factors). The three causal categories are not mutually exclusive; their interaction is indicated by the double-headed arrows. Multiple causality of speech production errors is indicated by the broken lines between the circles, reflecting permeable boundaries.

It is important to note that while all of the abovementioned factors can negatively influence speech production, the most extensive research has been conducted on the role of speech mechanism factors. Hence, this area is the most detailed in the discussion below. Researchers have taken cognizance of developmental and psychosocial

factors, but their effects on speech sound production are less understood. This does not refute the importance of such factors; it simply means that the contribution of developmental and psychosocial factors has not been clearly specified and require further research.

Following is a discussion of each of the factors:

- A. Speech mechanism factors
- B. Developmental factors
- C. Psychosocial factors

This discussion is provided as background information; the role of these factors in the speech production of the present subjects are not investigated directly and no causal relationship is postulated between the factors described and the speech sound production patterns observed in the present subjects.

#### A. Speech Mechanism Factors

Impairment of the oral mechanism in cleft palate has been cited as the single most important contributory factor to speech sound production disorders (Morris, 1968; Spriestersbach, 1965; Van Demark, 1966). The observation that not all cleft palate children present with deviant speech production patterns prompted researchers to investigate more thoroughly which factors of oral structural impairment are predictive of aberrant speech. The following major etiological structural and physiological factors have been specified in the literature (Bzoch, 1979; Edwards, 1980; McWilliams et al., 1984; Morris, 1968; Spriestersbach, 1965).

1. Extent of the original cleft
2. Velopharyngeal incompetence
3. Dental and occlusal anomalies
4. Presence of oro-nasal fistulae
5. Nasal and pharyngeal obstruction  
Tongue posture
7. Middle ear disease and hearing loss (it is recognised that this factor is not directly related to speech mechanism)

factors. However since middle ear disease is organically based, its inclusion in this section was deemed appropriate).

8. Surgical variables such as timing of surgery and the nature of the surgical technique
9. Orthodontic and/or prosthodontic variables

#### 1. Extent of the original cleft

The relationship between the severity of the original cleft and subsequent speech outcome has been investigated by several researchers (Bzoch, 1965; Fletcher, 1978; Krause, Tharp and Morris, 1976; McWilliams et al., 1984; Moll, 1968; Ross and Johnston, 1972; Spriestersbach, Darley and Rouse, 1956; Spriestersbach, Moll and Morris, 1961).

As would seem logical, the general finding revealed by the abovementioned research as well as clinical observation, indicates that the more severe the cleft involvement, the greater the likelihood of disordered speech production. Clefts of the lip only or the lip and alveolus are rarely associated with speech sound production errors (McWilliams et al., 1984; Ross and Johnston, 1972). Children with complete bilateral clefts of the lip, alveolus, hard and soft palates show worse speech sound production proficiency than those with unilateral complete clefts (Spriestersbach et al. 1961). However, common to both groups is the predisposition for maxillary arch collapse and/or velopharyngeal incompetence which may negatively influence speech sound production. Some researchers, notably Glover (1968, cited by Ross and Johnston, 1972) and McWilliams and Matthews (1979) have noted that children with isolated or incomplete clefts of the hard and soft palate are inclined to have poorer speech production skills than those children who have complete clefts. They reason that poor speech may be attributable to the fact that isolated palatal clefts are frequently horse-shoe shaped and wide at birth with extensive tissue deficiency. Further, isolated cleft palates are

sometimes associated with other congenital anomalies which may affect speech sound production, e.g. Crouzon disease (McWilliams et al., 1984).

Despite these general trends, accurate prediction of speech outcome on the basis of the extent of the congenital cleft alone is difficult because of several coexisting variables which may influence the development of speech. The extent of the original cleft in relation to the speech production skills of individual subjects is further described when the findings of the present study are discussed in Chapter 8.

## 2. Velopharyngeal incompetence

It is widely accepted that velopharyngeal incompetence is the primary causal factor for deviant speech production in children with cleft palate. Velopharyngeal incompetence may be defined as the inability to seal off the nasal from the oral cavity during speech production, thus altering the required balance of oral-nasal resonance (Bradley, 1979). The critical point at which velopharyngeal incompetence results directly in deviant speech production has not yet been clearly established (Morris, 1968). This is accounted for by the interaction of numerous variables pertaining to velopharyngeal function and structure, including length and mobility of the soft palate in relation to the depth of the pharyngeal port, firmness of velopharyngeal closure, timing or synchrony of the movements of velopharyngeal closure in relation to oral articulation and laryngeal vibration, the size of the velopharyngeal opening and consistency of velopharyngeal closure during speech activity (Osberg and Witzel, 1981; McWilliams, 1985).

Velopharyngeal incompetence affects the production of vowel and consonant sounds. As a result of the inability to direct the airstream orally, pressure consonants may be nasally emitted. Of the pressure consonants affected by velopharyngeal incompetence, the

production of fricatives and affricates is more vulnerable to error than the production of stops (Subtelny and Subtelny, 1959). This has been related to the fact that fricatives and affricates require the speaker to sustain the velopharyngeal closure for a longer period of time than that which is required for stop production. With regard to the production of vowels in the presence of velopharyngeal incompetence, the vocal tract system may absorb a greater amount of energy than that which occurs in speakers with normal oral and pharyngeal structures, resulting in *hypernasal resonance for vowel sounds* (Curtis, 1968).

In an attempt to compensate for velopharyngeal incompetence and to avoid nasal escape of the airstream, speakers may employ combinations of learned physiological phenomena. These include the production of laryngeal and pharyngeal substitutions, which do not depend on velopharyngeal competence for their accurate articulation (Bzoch, 1965; 1979), the use of a quiet speaking voice which tends to make the nasal escape of air less audible (Ross and Johnston, 1972; Wells, 1971), facial or nasal grimacing to attempt to "physically" close off the nasal cavity by contraction of the nostrils (Bzoch, 1979; or altering the tongue posture in a posterior direction so as to "prop" up the velum, which in turn leads to faulty patterns of speech production e.g. palatalisation of alveolar consonants (Morris, 1984).

The consistency of velopharyngeal closure may vary in individual speakers under different speaking conditions, and therefore cannot be viewed as an "all-or-none" phenomenon. Morris (1984) noted that some speakers with borderline velopharyngeal competence can achieve adequate velopharyngeal closure for speech during single sound or simple word repetition tasks, but cannot maintain this closure during *connected speech*, where rate and phonetic context are variable. In this regard, inconsistent velopharyngeal closure has important implications for the assessment of speech sound production in children with cleft palate. In order to obtain an accurate

description of a speaker's speech production proficiency it is necessary to supplement single word elicitation tasks with a sample of connected speech. This issue is considered in greater detail in Chapters 4 and 5, in relation to the selection of data collection procedures.

Despite the importance of velopharyngeal competence for normal speech sound production, researchers (Fletcher, 1978; Morris, 1968; Saxman, 1972; Van Demark, 1966) have found that on average, velopharyngeal incompetence accounts for about 25% of the total variance in articulation scores. Other variables, such as those discussed in this chapter, account for the remaining 75% of the variance in disordered speech production (Saxman, 1972).

In the present study, velopharyngeal function is assessed by means of a qualitative examination of the oral mechanism. Therefore only broad inferences about velopharyngeal function are possible in relation to the patterns of speech sound production observed in individual subjects (Chapter 7). No attempt is made to correlate speech patterns with competence of the velopharyngeal mechanism.

### 3. Dental and occlusal anomalies

The relationship between dental and occlusal anomalies and speech sound production is not clearly established. McWilliams et al. (1984) note that occlusion and dentition play an important role in establishing the size and configuration of the oral cavity.

Malocclusions may alter the tongue posture and movement e.g. the tongue may protrude beyond the dental arches, thus affecting the production of sibilants and alveolar stop consonants. Errors in the production of labial and labiodental consonants may occur in cases where the normal relationship between the mandible and maxilla is disturbed (Starr, 1979).

Dental anomalies alone do not often contribute directly to disordered

speech production (McWilliams et al., 1984). However, edentulous spaces, due to missing upper lateral incisors may affect the formation of an adequate cutting edge against which air is channelled for the production of /s/ and /z/ consonants (Bzoch, 1979; Morris, 1968).

Despite the possible effects of dental and occlusal anomalies on speech sound production, most researchers (Bloomer, 1971; Fletcher, 1978; McWilliams et al., 1984; Spriestersbach, 1965; Starr, 1971) are of the opinion that cleft palate children are generally able to compensate successfully for these deviations since a wide range of acoustically acceptable speech responses are possible in the context of such anomalies. However, when dental and/or occlusal anomalies are marked and are accompanied by other physiological and anatomical abnormalities (e.g. velopharyngeal incompetence, deviant tongue posture, intellectual deficiencies, and/or hearing loss), the ability to compensate adequately may be reduced (Fletcher, 1978; Starr, 1979).

The dental and occlusal characteristics in the subjects of the present study are described in Chapter 4. However, these are not correlated with deviant speech sound production.

#### 4. Presence of oro-nasal fistulae

Oro-nasal fistulae may occur as a result of breakdown of primary palatal surgical repair or they may reflect a surgeon's intention to facilitate uninterrupted growth of palatal shelves in the case of a wide palatal cleft. The latter are frequently the sequelae of two-stage palatal repair procedures (Oneal, 1971). Irrespective of their origin, oro-nasal fistulae have similar effects on speech production.

Oro-nasal fistulae affect oral-nasal resonance as well as the production of pressure consonants. While all pressure consonants may be affected to some degree, /s/ production seems particularly vulnerable (Ross and Johnston, 1972). Some children may adopt

compensatory tongue postures (e.g. posterior tongue placement in the production of anteriorly produced consonants) in an attempt to occlude the fistula (Cosman and Falk, 1980). This may alter the distinctive place feature of the target sound, giving rise to a reduction in phonemic contrast e.g. /s/ and /ʃ/ may both be produced as the palatal fricative /ç/.

#### 5. Nasal and pharyngeal obstruction

Obstruction of the nasal or pharyngeal airway, such as deviations of the nasal septum, vomerine spurs, thickening of the nasal mucosa, nasal pathway atresia, the presence of enlarged tonsils, wide pharyngeal flaps and speech bulbs which are too large, can result in hyponasal resonance (Bzoch, 1979; McWilliams et al., 1984). If hyponasality is severe, it may be accompanied by the loss of the oral-nasal phonological contrast e.g. [m] may be produced as [b], a relevant consideration in terms of the present study.

#### 5. Tongue posture

A number of researchers (Fletcher, 1978; Lawrence and Philips, 1975; Powers, 1962) have suggested that impaired speech production may arise, at least in part, from disturbances in tongue posture and function of the tongue.

Abnormal tongue positioning has been found in speakers who display velopharyngeal incompetence (Lawrence and Philips, 1975; Powers, 1962). In a cinefluorographic study, Powers (1962) noted that several patients with velopharyngeal incompetence elevated and retracted the tongue to a greater extent during speech than did normals, in an unconscious attempt to occlude the velopharyngeal port. In such cases, poorer speech production proficiency was noted than in those who did not adopt such compensatory postures. Posterior tongue posture modifies the production of alveolar and alveopalatal consonants with /s/ most frequently affected followed by /k/, /g/, /t/ and /θ/ (Lawrence and Philips, 1975). In addition to compensatory



posterior tongue postures, Fletcher (1978) observed several cases of anterior tongue displacement during speech production. He suggested that such anterior tongue posture has a more deleterious effect on consonant production than posterior tongue posture since it inhibits and reduces the maneuverability of articulatory movements.

In the present study, tongue posture is not studied directly. However, place of articulation as it affects the phonemes of English is described in some detail.

#### 7. Middle ear disease and hearing loss

There is general agreement among researchers that there is a higher incidence of middle ear disease and conductive hearing loss among speakers with cleft palate than among normal speakers (Paradise, 1982; Paradise and Bluestone, 1974; Stool and Randall, 1967; Yules, 1975). The hearing loss is usually bilateral, although it may shift from one ear to the other as it develops and resolves, and may be episodic or fluctuating. The degree of hearing loss may vary between 5 and 55dB (McWilliams et al., 1984). Otitis media and hearing loss are most prevalent during infancy, but episodes decrease with age and following soft palate repair (Heller, Hochberg and Milano, 1970; Paradise and Bluestone, 1974).

In view of the multiple causality of speech and language disturbances in children with cleft palate, it is difficult to determine the effects of recurrent and fluctuating hearing loss on speech and language development. This has possibly deterred research in this area. In contrast, some studies have been conducted in non-cleft palate children with histories of recurrent otitis media and hearing loss. Holm and Kunze (1969) and Needleman (1977) found poorer performance in children with early conductive hearing loss than in normals on speech and language related tasks. Shriberg and Smith (1980), using non-cleft palate children, conducted phonological process analysis on the spontaneous speech samples of two groups of

children, one with and one without a history of recurrent otitis media. They found two sound changes present in the otitis media group which were absent in the second group. The first sound change involved either the deletion of initial singleton consonants or their replacement by [h] or [ʔ]. The second sound change affected nasal consonants which were either interchanged with other nasals, partially denasalised, replaced by oral stops or accompanied by an epenthetic stop. These authors noted that such sound changes, particularly the first, are reminiscent of the speech of cleft palate individuals.

Studies in this area have been criticised for poor design, unspecified nature of the hearing loss, retrospective data collection and insufficient information regarding the status of the disease (Paradise, 1982). Menyuk (1980, cited by McWilliams et al., 1984) proposed that otitis media could have repercussions for some children. She suggested that several factors, including the age of the child when otitis media is contracted and the medical management thereof, the frequency and duration of the episodes, the extent of the accompanying hearing loss, the child's home environment, and the intelligence of the child, all interact with the otitis media to create problems in some children and not others.

In summary, therefore, the relationship between recurrent otitis media, mild conductive hearing loss and speech development remains unclear, although it does seem that under certain conditions, this variable may contribute to disordered speech production. The fact that cleft palate children are at risk for conductive hearing loss is important, and requires consideration in the evaluation and treatment of speech disorders. In the present study, while the possibility of conductive hearing loss was considered in the selection of subjects, the criterion of a negative history of middle ear pathology and hearing loss could not be specified. Instead, hearing testing was conducted to ensure that subjects were able to respond appropriately

in the experimental procedure. This issue is discussed further in Chapter 5.

#### 8. Surgical variables

Professionals concerned with cleft lip and/or palate habilitation seem unanimous that the primary goal of surgery is to provide the patient with a functionally adequate oral structural mechanism as early as possible to facilitate feeding and to permit the development of normal speech. A second goal concerns socially acceptable cosmetic appearance.

Although recent developments in surgical techniques have improved the outlook for the child with a cleft palate, several variables in surgical management may influence the development of speech. Perhaps the most important of these is the age at which primary surgical repair is conducted.

Consultation with the surgical literature reveals that most surgeons perform primary lip repair at approximately three months of age (Grabb, 1971). In cases of bilateral cleft lip, this procedure is sometimes delayed or is performed using a two-stage lip closure procedure. However, the age at which cleft palate patients undergo primary surgical repair of the cleft has been the subject of much controversy in the surgical, speech pathology and orthodontic literature. Consequently, scheduling of palatal repair varies among the treatment centres of the world; each centre reflecting the particular philosophy of the cleft palate management team.

The scheduling of primary palatal repair may follow one of two broad philosophies which seem to emerge from the literature. The first philosophy advocates early palatal repair in a one-stage procedure, generally before the child is two years of age, although some suggest even before the age of one year. Proponents of this approach argue that it is important to provide the patient with a functionally

adequate oral mechanism before the commencement of the language and speech sound acquisition process. They suggest that early closure would prevent the child from developing undesirable neurophysiological compensatory articulations, difficult to remediate in later years (Bardach, Morris and Olin, 1984; Cosman and Falk, 1980; Dorf and Curtin, 1982; Witzel, Salyer and Ross, 1984).

The second philosophy proposes primary palatal repair in a two-stage procedure, the critical aim of which is to prevent abnormalities due to maxillary arch growth retardation or mid-face collapse. According to this second approach, primary repair of the soft palate is conducted before the child is one year, between 7-9 months of age. Primary repair of the hard palate is delayed until the child is older; the age ranges from four or five years to adolescence in some cases (Schweckendiek, 1978; Hotz, Gnoinski, Perko and Nussbaumer, 1977, cited by Bardach et al., 1984). Advocates of this philosophy argue that delay in hard palate repair permits spontaneous narrowing of the cleft through undisturbed growth of the palatal shelves, thus averting mid-facial collapse. They also suggest this approach facilitates a technically better result because of the increased availability of tissue required for flap mobilization (Schweckendiek, 1978).

Speech outcome and mid-facial growth have been evaluated in both approaches. However, these evaluations are usually conducted by the champions of the particular approach and may contain experimental bias. Proponents of early palatal repair claim superior speech outcome with minimal or no mid-facial growth retardation (Cosman and Falk, 1980). In contrast, Bardach et al. (1984), who evaluated the results of a series of patients who had had delayed hard palate repair, reported no marked disturbances in mid-facial morphology, but poor speech results, characterised by frequent compensatory laryngeal and pharyngeal substitutions, pervasive audible nasal emission and hypernasality.

The timing of surgical repair of cleft lip and palate in Johannesburg where the present study was conducted, represents an approach which reflects the two philosophies described above. As is common in most cleft palate centres world-wide, the cleft lip is repaired at approximately three months. However, surgeons vary with regard to the timing of primary palatal repair. Certain plastic surgeons prefer to repair the soft and hard palatal clefts in a one-stage procedure at approximately 18 months or earlier. Other plastic surgeons conduct palatal repair in cases of unilateral or bilateral complete clefts in a two-stage procedure. In such cases the soft palate is repaired between 9-12 months and closure of the hard palate is delayed until 3-4 years, depending on the width of the residual cleft. In cases of clefts of the soft palate, the repair may be conducted in a one-stage procedure at approximately one year of age (Chait, 1985). To the writer's knowledge, no information regarding speech outcome or characteristics of mid-facial growth following this surgical approach has been documented.

To date, timing of palatal repair remains unresolved and deserves rigorous, prospective and longitudinal investigation (Spriestersbach, Dickson, Fraser, Horowitz, McWilliams, Paradise and Randall, 1973). The age at which the subjects of the present study underwent primary surgical repair receives further attention in subject description (Chapter 5).

#### 9. Orthodontic and/or prosthodontic variables

In certain cases, orthodontic or prosthodontic management of the cleft and its sequelae is required. In children with cleft palate, orthodontic treatment usually involves the moving of teeth or palatal segments to correct dental or occlusal malalignment. Prosthodontic treatment aims to replace missing oral structures; in the case of cleft palate, this usually involves obturation of a residual cleft palate or oronasal fistula or the velopharyngeal space (Goldstein,

1982; Starr, 1979). Although one of the chief goals of orthodontic and prosthodontic treatment is to facilitate normal oral functioning, in some cases speech sound production may be adversely affected.

Orthodontic and prosthodontic treatment frequently involves the fitting of removable appliances. Appliances to expand a narrowed maxillary arch may affect kinesthetic and proprioceptive feedback and hence tongue movements. Poorly fitting obturators, e.g. those which are too thick, too wide or have incorrect contour may have a similar effect on speech sound production, particularly alveolars and sibilants (Starr, 1979). Furthermore, speech bulbs which are either too wide or too narrow may affect the oral-nasal resonance balance and may result in hyponasality or hypernasality respectively.

It appears that the effects of orthodontic and prosthodontic management alter the speech sound production in a phonetic sense, i.e. they result in distortions and seldom affect the phonemic characteristics of the target sounds.

#### Summary of speech mechanism factors

The above discussion indicates that several factors relating to oral structural impairment are important in contributing to disordered articulation in cleft palate children. In some cases a direct relationship between deficient oral structure and function, and speech proficiency may be postulated, e.g. velopharyngeal incompetence, nasal and pharyngeal obstruction. With other factors, however, further research is required before cause-effect assumptions can be made about their relationship to speech production, e.g. dental and occlusal anomalies, hearing loss, surgical variables. Nevertheless, impaired oral structure and function accounts for only a portion of the variance in disordered speech production (Bzoch, 1979; Morris, 1979; McWilliams et al, 1984; Van Demark, 1966). Developmental and psycho-social factors may be equally important and are considered in the following section.

### B. Developmental Factors

The assumption that impairment of the oral speech mechanism cannot alone account for disordered speech production in cleft palate children may be inferred from three frequent clinical observations. Firstly, not all children with velopharyngeal incompetence give evidence of gross laryngeal and pharyngeal substitutions, hypernasality and/or audible nasal emission, and some children demonstrate such articulatory phenomena despite their ability to achieve some velopharyngeal closure during speech (McWilliams, et al., 1984). Secondly, some patients persist in the production of deviant speech even after they have the structural and functional capacity for normal speech production (Bzoch, 1979; Morris, 1968). Thirdly, cleft palate children frequently display errors in the production of liquid consonants, such as /r/ and /l/, which are difficult to explain in terms of velopharyngeal incompetence since these sounds do not require high intra-oral air pressure (Van Demark et al., 1979).

Learning and maturation factors, and linguistic and cognitive competence are important variables which may affect speech sound production in children with cleft palate (Bzoch, 1979; Edwards, 1980; Morris, 1968; McWilliams et al., 1984). These factors have received less attention in the literature than oral structural and physiological correlates. This is possibly because these factors are not clearly understood. Further, the impact of developmental factors on speech sound production is insidious, complex and in most cases abstract in the sense that they are not readily amenable to direct observation and measurement. Despite this, their influence on speech sound production is usually apparent (Morris, 1968; Spriestersbach, 1965).

#### 1. Maturation and learning factors

Considerable evidence supports the fact that learning and maturational factors play an important role in the development of

speech sound production disorders in cleft palate children (Bzoch, 1979; Edwards, 1980; McWilliams et al., 1984; Van Demark, 1966). Since normally developing children acquire speech proficiency gradually, the expectation is similar in cleft palate children. During early phonological acquisition, both normal and cleft palate infants display errors of speech sound production in their attempt to master the sounds of their language. The findings of several research studies have indicated that children with cleft palate are delayed in their development of communication skills both with respect to speech sound production and receptive and expressive language abilities (Bzoch, 1979; Faircloth and Faircloth, 1971; Philips and Harrison, 1969).

The question arises as to whether the development of speech sounds reflects normal acquisition patterns, albeit delayed, or whether the speech sound production patterns deviate markedly from the normal developmental scheme. This question is dealt with in depth in the present study (Chapters 6, 7 and 8).

It would be expected that by 4.0 - 5.0 years (the age range of the subjects in the present study) the majority of the consonants of English would be established in normally developing children (Grunwell 1982; Prather, Hedrick and Kern, 1975; Shriberg and Kwiatkowski, 1980). Grunwell (1982) outlined seven stages in development of phonology and specified the sounds that might be expected at each stage. Table 1 shows the commonly observed phonological systems of children at stages VI and VII corresponding approximately to the age of the subjects in the present study. The sounds are grouped according to place and manner of articulation.



Table 1: Phonological contrasts expected in normally developing children aged 3;6 - 4;6 years (taken from Grunwell, 1982)

STAGE VI (3;6-4;0) (4;0-4;6)	p	m	b	t	n	d	tʃ	dʒ	k	ŋ	g	h
	f		v	s		z						
	w			l		(r)	j					

STAGE VII (4;6>)	p	m	b	θ	ð	t	n	d	tʃ	dʒ	k	ŋ	g	h
	f		v			s		z						
	w					l		r	j					

According to this scheme, the sounds late in developing are the interdental fricatives /θ/ and /ð/, the alveopalatal fricative /tʃ/, and not included in this chart, complex consonant clusters (Shriberg and Kwiatkowski, 1980).

Certain errors of production commonly observed in children with cleft palate are similar to those demonstrated by non-cleft palate children. These include deletion of final consonants, reduction of consonant clusters, the replacement of stops for fricatives, and difficulty in the production of the liquids /r/ and /l/ (Bzoch, 1965; Edwards, 1980; Hodson, et al., 1983; Lynch et al., 1983; Moll, 1968; Priestersbach, Darley and Rouse, 1956). Since cleft palate children are reported to be delayed in their development of speech, the above errors may persist longer than the age at which they are resolved in normally developing children.

In contrast, compensatory articulatory manoeuvres, described earlier in this chapter, do not generally occur in the speech of normally developing children, although glottal stop articulation has been reported in certain non-cleft palate phonologically disordered children (Ingram, 1976). Compensatory productions are learned responses, resulting from impaired oral structure and function. These

speech responses may be developed early on in the speech acquisition process prior to palatal repair, may be positively reinforced and may become habituated. As was mentioned earlier, they may persist even after palatal repair has been completed (Bzoch, 1979).

Thus, maturation and learning factors may be reflected in patterns of speech development common in normal children as well as in those resulting from impaired oral structure and function. By examining patterns of speech sound production, it is possible to determine this distinction.

## 2. Linguistic competence

Several studies have suggested that children with cleft palate are retarded in their development of language skills (Faircloth and Faircloth, 1971; Morris, 1968; Nation, 1970; Philips and Harrison, 1969). Shames and Rubin (1979) documented delayed expressive and receptive language development, but noted that linguistic "catch up" began in children at approximately three years of age and that by five years, cleft and non-cleft subjects were indistinguishable in this respect.

Certain authors (Faircloth and Faircloth, 1971; Paul and Shriberg, 1982) have recognised a synergistic relationship between articulation proficiency and syntactic performance in both cleft palate and non-cleft palate children. Faircloth and Faircloth (1971) considered the relationship between language skills and speech sound production proficiency in 10 articulation disordered cleft palate children aged 6-11 years. They concluded that those children who concentrated on achieving the best possible articulatory patterns did so at the expense of syntactic complexity, while those who used more elaborate sentence forms sacrificed articulatory complexity in order to do so.

In the present research, syntactic competence was not investigated. However, in the clinical situation the role of linguistic factors in the communication problems of children with cleft palate cannot be

ignored.

### 3. Cognitive factors

In the search for the effects of cleft palate and its sequelae on communication functioning, attention has been paid to the effects of intelligence. Lamb, Leeper and Wilson (1973) and Goodstein (1968) showed slightly depressed verbal intelligence quotients in cleft palate children when compared with normal children.

Recent studies (McWilliams and Musgrave, 1979; Richman, 1978) have found no reduction in intelligence that could be directly related to the cleft and no discrepancy between verbal and performance intelligence quotients. Morris (1979) sums up his point of view regarding intelligence in cleft palate individuals:

It is most important to realise ...that most patients with cleft palate demonstrate levels of intellectual function higher than that which is relatively certain to affect speech and language development. Clearly then, level of intelligence is not a major cause of articulation problems of the majority of cleft palate cases" (p. 184).

### Summary of developmental factors

The foregoing discussion has revealed the important and influential role maturational and learning factors play in the development and maintenance of speech sound production disorders in cleft palate children. These factors relate both to patterns of delayed but normal speech sound acquisition and to patterns of deviant production such as those evidenced by compensatory articulation. This distinction between phonological delay and phonological deviance forms a prominent focus in the present study. The effects of linguistic and cognitive factors require further research to determine the precise nature of their contribution to speech sound production disorders in cleft palate children.

### C. Psychosocial Factors

Several studies have attempted to assess emotional and social maturity, psychological adjustment and personality factors in

children with cleft palate (Clifford, 1979; Goodstein, 1968). These studies have, in the main, revealed inconclusive results demonstrating little or no difference between cleft and non-cleft palate children with regard to psychosocial development.

It is possible that parental attitudes may affect the child's development of articulation skills. Bzoch (1979) observed that a child's first speech attempts may be so unintelligible that they are not recognised as such, and the family may consequently fail to provide the reinforcement and stimulation necessary for the development of speech and language skills. This in turn, may reduce the child's attempts to communicate and may impede his ability to "practise" the sounds of his language.

Although it is accepted that psychosocial factors may be etiologically significant in accounting in part for the articulation problems in cleft palate speakers, this factor does not receive attention in the present study.

### III. SUMMARY

This chapter has discussed the etiological factors related to speech sound production disorders in children with cleft palate. This information was presented as a framework for interpretation of the findings of the study. As mentioned previously, no attempt is made to correlate the findings of speech patterns with any one etiological factor.

This chapter has highlighted the fact that impairment of the oral structure and function plays a central role in disordered speech production. In addition, the interaction of oral structural and functional characteristics with developmental and psychosocial factors is crucial in the acquisition of speech in cleft palate children.

### CHAPTER 3

#### THE APPLICATION OF PHONOLOGICAL THEORY TO DISORDERED SPEECH SOUND

##### PRODUCTION

The past two decades have witnessed what may be termed a paradigm shift (Kuhn, 1970) in the classification, description and clinical management of speech sound disorders. This chapter traces the development of the clinical approach to management of cleft palate and non-cleft palate children with speech sound production disorders. The early focus on etiological factors in classifying articulation disorders and the extensive use of the segmental (single sound) approach to the evaluation and remediation of these disorders is described. The shift in emphasis from single segments to underlying patterns of speech production is highlighted by the recent application of linguistic principles of generative and natural phonological theory to the management of speech sound production disorders. The rationale is developed for the theoretical framework on which the present study is based.

##### I. CLASSIFICATION OF DISORDERS OF SPEECH SOUND PRODUCTION

In the early years of speech pathology (1930's and 1940's), articulation disorders were viewed in terms of the medical model (Van Riper, 1939). This model sought to determine causal factors for various behaviours or events. In this tradition, disorders of speech sound production were classified in terms of their functional or organic causes (Van Riper, 1939). "Organically based articulation" disorders arose from identifiable physiological or structural causes, while "functionally based articulation" disorders had no identifiable structural or physiological etiology. Examples of organically based articulation disorders include the conditions of cleft palate, dental anomalies and neurological impairment such as dysarthria and apraxia. "Functional articulation disorder" was the default term used to describe articulation disorders unrelated to direct structural or

physiological impairment. Attempts were made to discover the possible underlying causes and possible explanations included motor coordination, speech sound discrimination, inappropriate learning, intellectual and emotional variables (Powers, 1971). However, the role of these factors remained unclear.

With the increasing influence of the behavioural model in psychology, researchers began to classify articulation disorders in terms of their behavioural manifestations (Mowrer, 1952; Olmsted, 1966). These researchers held that the principles of learning theory such as operant conditioning, reinforcement, and successive approximation governed the acquisition of speech sounds (Ferguson and Garnica, 1975). Within the behavioural model, articulation disorders were categorised according to the level of the speech sound system most prominently affected. Researchers such as Winitz (1969) drew the distinction between those speech disorders which affected the motor movements required to achieve acceptable speech production (the phonetic level) and those which affected the learning of abstract linguistic rules (the phonological level). This distinction still retained the elements of the medical model in that phonetic speech disorders resulted from anatomical and physiological deficits. In other words, the problem lay in the execution of the motor movements required for speech production, in the presence of an intact phonological system. Phonological disorders, in contrast, resulted from disturbances in the organization of linguistic or phonological rules in the presence of an intact phonetic system. Although each dimension of the phonetic-phonological dichotomy has been the subject of lively debate, this classification system has been retained and is reflected in the work of current day researchers and clinicians (Grunwell, 1981, 1982; Ingram, 1976; Shriberg and Kwiatkowski, 1980). The details of this debate are presented later in this chapter.

## 11. CLINICAL APPLICATION OF PHONOLOGICAL THEORY TO THE EVALUATION AND TREATMENT OF SPEECH SOUND PRODUCTION DISORDERS

The description, evaluation and treatment of speech sound production disorders has paralleled the development of phonological theory. Since the 1940's, each clinical approach to children with speech sound production disorders has reflected the dominant phonological theory of that time. The principles and procedures of phonological analysis have provided speech pathologists with a framework for the description of disordered speech production, and reciprocally, disordered speech production forms a testing ground for phonological theories (Broen, 1982; Grunwell, 1982). In this section, three major phonological theories (taxonomic, generative and natural phonology) and their clinical impact on the approach to management of disordered speech sound production are briefly described. Where applicable, the extension of such phonological procedures to speech of cleft palate speakers is elucidated. The broad concerns of each theory and their clinical applications are summarised in Table 2.

Table 2 : Parallels between the development of phonological theories and their impact on the management of disordered speech sound production

PHONOLOGICAL THEORY	BASIC THEORETICAL CONSTRUCTS	APPLICATION TO SPEECH PATHOLOGY
TAXONOMIC PHONEMICS (Bloomfield, 1933, cited by Edwards and Stryberg, 1983)	CONTRASTIVE PROPERTIES OF INDIVIDUAL PHONEMES	TRADITIONAL APPROACH TO EVALUATION (Templin and Harley, 1968) AND THERAPY FOCUSING ON INDIVIDUAL SEGMENTS (Van Riper, 1959; Winitz, 1969)*
GENERATIVE PHONOLOGY (Chomsky and Halle, 1968)	DISTINCTIVE FEATURES	DISTINCTIVE FEATURE ANALYSIS (Irwin and Wong, 1963; Singh, 1976) AND THERAPY (Costello & Ongline, 1976; McReynolds & Engman, 1979)
	GENERATIVE PHONOLOGICAL RULES	PHONOLOGICAL ANALYSIS AND THERAPY IN TERMS OF GENERATIVE REALISATION RULES (Compton, 1976)#
NATURAL PHONOLOGY (Stampe, 1969)	PHONOLOGICAL PROCESSES	PHONOLOGICAL PROCESS ANALYSIS ( Ingram, 1975; Stryberg & Kwiatkowski, 1980) AND THERAPY (Madson and Paden, 1983; Delner, 1979)

\* Organically and functionally based articulation disorders were treated in the same fashion

# These approaches generally focused only on the child whose disordered speech had no identifiable physical etiology

#### A. Taxonomic Phonemics

Until the late 1960's the predominant approach to the evaluation and treatment of speech sound disorders focused primarily on individual segments. Authors, such as Van Riper (1963), Winitz (1969), Powers (1971), did not seem to link their work to any particular phonological theory. If a theoretical anchor were to be speculated retrospectively, however, the work of the speech pathologists during this period seems reminiscent of the theory of taxonomic phonemics. The taxonomic model prevalent in the 1940's and 1950's focused on the individual phoneme. Briefly, taxonomic phonologists such as Bloomfield (1933, cited by Edwards and Shriberg, 1983) were concerned with the identification of the contrastive phonemes of various languages as well as the description of the phonetic contexts in which they occurred (Broen, 1982; Edwards and Shriberg, 1983; Ingram, 1976). Greatly influenced by the behavioural paradigm, these theorists focused on describing observable events and as such paid little attention to the notion of linguistic or phonological competence. Thus, phonemes were seen as independent from each other and from the other levels of language (Edwards and Shriberg, 1983).

The studies of child phonology in this period reflected the taxonomic model. Two types of research design were employed to gather information on the acquisition of phonology, namely diary studies of individual children's speech (Leopold, 1947; Velten 1943, cited by Ingram, 1976) and cross-sectional studies (Poole, 1934; Wellman, Case, Mengert and Bradbury, 1931, cited by Ingram, 1976) which aimed at obtaining normative speech sound production data on large numbers of children at varying stages of acquisition.

The cross-sectional studies, particularly that of Templin (1957), provided the impetus for the development of assessment and remediation procedures for speech sound production disorders, many of which are still used today. In this approach, articulation disorders



are evaluated using articulation tests, such as Templin-Darley Test of Articulation (Templin and Darley, 1969), Goldman-Fristoe Test of Articulation (Goldman and Fristoe, 1969), Photo Articulation Test (Pendergast, Dickey, Selmar and Soder, 1969), among others. These tests have similar features. Typically, a wide range of English consonants (singletons and sometimes consonant clusters) is assessed in varying word positions. Subjects are often required to name objects or pictures containing the target consonant. Some tests, for example, the Goldman-Fristoe Test of Articulation, elicit connected speech samples. Responses are either spontaneous or imitated. Scoring procedures vary from a simple tally of correct or incorrect to a categorisation of the error form in terms of omission, distortion, addition or substitution. In some cases, both quantitative and qualitative scoring procedures are followed. The advantages and disadvantages of these methods of data collection and analysis are outlined in Chapter 4, in relation to the methodology employed in the present study.

The approach to the evaluation of speech sound production disorders in children with cleft palate is similar to that described above, and has remained as such despite the advances in the clinical application of phonological theory. Until the 1950's, the approach to speech sound production problems in cleft palate patients stressed the importance of strengthening the velopharyngeal mechanism for speech and reducing hypernasality and audible nasal emission (Van Riper, 1942). As the focus shifted to include articulatory as well as resonance disorders, clinicians used articulation tests developed for the assessment of speech sound production in children with functional articulation disorders. In addition, single word and sentence repetition tasks, several of which are in current use, were specifically constructed to tap the production of pressure consonants frequently found to be in error, e.g. Iowa Pressure Articulation Test (Morris, Spriestersbach and Darley, 1961) and the Simulated Sentence

test (Van Demark, 1964). Later, the Bzoch Error Pattern Diagnostic Articulation Test (1979) was published which took into consideration, both in construction and scoring, the possibility of errors directly related to the cleft as well as those related to developmental delay. Several authors (including Darley, 1978; Van Demark, 1964; Wells, 1971) stressed the importance of obtaining conversational speech samples to ascertain the extent to which speech sound production is influenced by contextual factors. These articulation tests were used to determine whether or not the consonants of English were produced correctly and if not, the manner in which they differed from the target sound (Morris, 1979). Errors were coded either in terms of predetermined error categories, e.g. Bzoch (1979) or according to the articulatory movements used in the production of the various error sounds (Wells, 1971). In all cases, the emphasis remained on the production of individual segments.

Traditional remediation procedures for articulation disorders, still prevalent today, have largely emanated from the early work of Van Riper (1939). What distinguishes the traditional approach to articulation disorders in the 1950's and 60's from the similar approach used today, is that in the past, all articulation disorders, simple and multiple, functionally- and organically-based were treated in the same way. Currently however, the traditional approach seems restricted to children with isolated or simple articulation errors eg. /θ/ for /s/ and /w/ for /r/ or to children whose speech sound production disorders are organically related, as in cleft palate. In contrast, phonological-rule or -process based procedures (outlined below) are applied to children with severe "multiple articulation disorders" where there is no known organic cause for the disordered speech production.

The focus of the traditional approach stresses the individual consonants found to be in error. Articulation disordered children are taught to discriminate the error sound from the target sound

auditorily (Winitz, 1969), and are taught the motor skills necessary for the production of target sounds in isolation, syllables, words, sentences and in conversational speech.

This segmental or single sound approach has remained the most commonly used procedure for children with organically based speech sound production disorders, such as cleft palate. Bzoch (1979) has emphasized the need to teach production of segments in the early stages of therapy and to delay ear training procedures until accurate production has been achieved. Additional techniques, such as visual cues (Bzoch, 1979; Shprintzen, McCall and Skolnick, 1975) are employed to enhance the control of nasal escape of air and to direct the air stream orally. Heightened kinesthetic awareness of motor production is also stressed (Wells, 1971).

In recent years, clinicians have observed that "the usual methods of working on the mastery of articulation by one sound at a time are inappropriate for most of the error patterns of children and adults with cleft palates" (Bzoch, 1979, p. 293). Bzoch (1979) described a procedure of multiple sound articulation training in a child with gross pharyngeal and laryngeal substitutions. In this approach, groups of sounds, characterised by similar place or manner of production were taught using direct visual, kinesthetic and tactile cues. Bzoch found this procedure to be effective as it modified the "entire underlying pattern of glottal and pharyngeal constrictions rather than a limited part of the error pattern" (p. 297). This recognition of patterns of errors in children with cleft palate forms the basic rationale for the present study.

#### B. Generative phonological theory

The theory of generative phonology (Chomsky and Halle, 1968) had a marked influence on the conceptualisation, evaluation and treatment of speech sound disorders. This theory is radically different from that of taxonomic phonology. In contrast to the focus on individual

phonemes as independent units, generative phonologists view phonology as an integral part of grammar, referred to as a morphophonemic level or systematic phonemic level (Edwards and Shriberg, 1983). Generative phonologists abandoned the concept of the phoneme as an indissoluble unit, in favour of distinctive features which together comprise the characteristics of individual sounds (Broen, 1982). A distinctive feature is defined as the smallest individual characteristic of a segment contributing to the *meaningful difference between phonemes* (Schane, 1973). A set of generative or realisation rules is postulated to relate the morphophonemic level to the phonetic output. A primary distinction between generative phonology and taxonomic phonemics concerns the notion of underlying representation i.e. "the form in which words are identified or stored" (Ferguson, 1978, p. 287). Taxonomic phonologists hold that all the information necessary for the description of phonemic contrasts lies in the phonetic transcription (Broen, 1982). Generative phonologists, however, assume that morphemes have an underlying representation which is not necessarily present in the phonetic output. As such, one of the chief concerns of generative phonologists is to determine the nature of the underlying representation (Dinnsen et al., 1984).

Two important constructs of generative phonology, i.e. distinctive features and generative phonological rules, have had considerable impact on the development of evaluation and remediation procedures for children with disordered speech sound production.

#### 1. Distinctive features

Chomsky and Halle (1968) provided a means of specifying the phonemic contrasts in terms of the distinctive features. They proposed a set of 13 articulatory-based binary distinctive features, applicable to English.

The feature systems of Chomsky and Halle (1968) and Jakobson, Fant and Halle (1963) have been employed to trace phoneme acquisition in

normally developing children (Prather, Hedrick and Kern, 1975). Furthermore, procedures have been developed to analyse disordered articulation using distinctive features (McReynolds and Huston, 1971; McReynolds and Engmann, 1975). These researchers view articulation errors in terms of failure to master the distinctive features necessary to signal phonemic contrasts of the adult language.

Limited research has applied distinctive feature analysis to the description of speech sound production disorders in cleft palate speakers. Singh, Hayden and Toombs (1981) evaluated articulation errors of a large group of children (18 of whom had clefts of the palate) using distinctive feature analysis. The findings of this study indicated that the cleft palate subjects demonstrated a different feature hierarchy from that observed in the other articulation disordered subjects. Specifically, the cleft palate subjects showed the highest percentage correct for the feature of labiality and the lowest for the features of voicing and place. The same trends were reported in the single case described by Moller et al. (1983) even though a different feature system was used in analysis. The fact that distortion errors were excluded from the study by Singh et al. (1981) could have altered the outcome, particularly in cleft palate children who frequently display such errors.

Recently, the inherent characteristics of distinctive feature systems and their clinical application, as in the procedure of McReynolds and Engmann (1975), have been criticised on several grounds (Carney, 1979; Grunwell, 1982; Walsh, 1974). The criticism most frequently levelled concerns the degree to which the features are abstract. According to Grunwell (1982) "distinctive features were originally devised to account for an idealised level of language, often far removed from the physical realities of human speech" (p. 109).

Nonetheless, these features have been employed to transcribe actual sounds correctly or incorrectly articulated in clinical populations (Harris and Cottam, 1985). Further, Jakobson, Fant and Halle (1963) and Chomsky and Halle (1968) proposed that distinctive features were always binary. Grunwell (1982) argues:

there is no satisfactory logical justification for the hypothesis that the sound patterns of all languages operate on the binary principle...[this] leads to rather complex and indirect categorisations of place of articulation of consonants...[which] do not readily lend themselves to two-way contrasts (p. 108).

Other criticisms of these feature systems include their inappropriate and misleading specifications and definitions (Broen, 1982; Garney, 1979), the fact that phoneme description should include acoustic and perceptual distinctions in addition to the articulatory features (Ladefoged, 1971) and the observation that the feature systems do not account for distorted speech productions as they relate primarily to target English productions (Broen, 1982; Harris and Cottam, 1985). Furthermore, as Schwartz (1983) points out, distinctive feature analysis concentrates exclusively on the individual segment and therefore does not readily permit the description of sound or syllable omissions nor the possible influence of one phoneme over another.

In spite of these criticisms, remediation programmes (Blache, 1982; Costello and Onstine, 1976) have been implemented which aim at establishing absent or erroneous distinctive features in children with functional articulation disorders. To the writer's knowledge, no such studies have been published using subjects with cleft palate. At this time assessment and remediation using distinctive features requires careful investigation, particularly in regard to generalisation of newly acquired features (Hoffmann and Schuckers, 1984).

## 2. Generative phonological rules

In order to capture the underlying phonological patterns in

articulation disordered children, several researchers (Compton, 1970, 1976; Lorentz, 1976; among others) have postulated generative phonological rules. These rules, alternately referred to as "derivational rules" (Compton, 1970) or "substitution rules" (Oller, 1973), map the child's assumed underlying phonemic representation on to the surface or phonetic rules. Derivational rules reflect patterns of phonological organisation not readily discernible using the segmental approach (that of individual phonemes). Phonological rules may apply optionally or obligatorily and may characterise context sensitive or context free substitutions (Compton, 1976).

The generative phonological approach in this framework has been criticised, primarily because of the formalism and complexity associated with the postulation of generative rules (Ingram, 1976; Schwartz, 1983). However, recently it has received renewed consideration by speech pathologists such as Dinnsen and associates (1984).

#### C. Natural phonological theory

In the past decade, the principles of Stampe's (1969) theory of natural phonology, which grew out of the generative theory, have dominated the clinical phonology literature. Specifically, the notion of "phonological process" fundamental to the theory has enjoyed widespread attention. Stampe (1969) defined a phonological process as a simplification strategy which "merges a potential phonological opposition into that member of the opposition which least tries the restriction of the human speech capacity" (p.443). In a later definition, Stampe (1979, p.1, cited by Grunwell, 1982, p. 166) described a phonological process as a "mental operation that applies in speech to substitute for a class of sounds or sound sequences presenting a common difficulty to the speech capacity of the individual, an alternative class identical but lacking the difficult property". For example, a sound class (such as fricatives) which are apparently more difficult or less natural to produce is replaced by a

second sound class, which is easier or more natural to produce (such as stops).

Stampe's theory has made a significant contribution to the understanding of phonological development. According to this model, infants possess a set of universal, innate natural processes which eliminate all contrasts from the child's speech. As the infant's phonological system unfolds, the adult system internalised by the child, imposes constraints on these natural processes by limiting, suppressing and ordering their application until a direct match between the adult and child phonological systems is achieved. In other words, the child's task in learning language is to eliminate all those processes which do not occur in the adult language. The child's errors are therefore seen as the result of natural phonological processes which allow him to accommodate the adult phonological system to his immature speech production capacity. In addition, the errors are viewed as systematic events reflecting acquisition rather than random inaccurate productions (Broen, 1982).

Natural phonology assumes that a child's underlying phonological representation is equivalent to the adult system (Edwards and Shriberg, 1983). Underlying representation has been defined as a "lexical representation comprising the meaning and all idiosyncratic, learned phonological properties of a morpheme" (Dinnsen, 1984, p. 5). The claim of adult-like underlying representation has been criticised in recent years for the lack of supporting empirical evidence (Maxwell, 1984). In contrast to Stampe's view, Dinnsen (1984) and Maxwell (1984) have claimed that the phonological system of a child may contain both adult-like and non - adult-like underlying representations which can be established through the investigation of morphophonemic alternations. Ingram (1979) has also stressed that it is "necessary to consider the possibility that children actively operate on adult forms to establish their own phonological



representations of these words" (p.143). Outlining the importance of this issue, Dinnsen (1984) argues that whether or not the childrens' underlying representations are adult-like, may serve to differentiate phonologically disordered children in terms of severity of their disorder. may in turn have clinical implications for appropriate remediation planning.

The influence of Stampe's theory of natural phonology in the clinical arena was markedly increased with Ingram's seminal publication in 1976. Ingram applied the construct of phonological process to the re-analysis of several available studies of normally developing and articulation disordered children. The operational definition used was that phonological processes involved sound changes affecting entire classes of sounds (Ingram, 1976, p. 29). Ingram demonstrated that articulation errors are characterised by broad deficient patterns and that mastery of a sound system is not simply a matter of learning to produce individual segments; children must also learn to produce the appropriate syllable shapes and sequences. Since Ingram's publication, several studies have confirmed that disordered articulation is indeed systematic and can be described in terms of deficient underlying patterns or phonological processes (Dunn and Davis, 1983; Grunwell; 1981, among others). In addition, a number of studies have been conducted in which the speech of normally developing children was analysed for the presence of phonological processes (Dyson and Paden, 1983; Hodson and Paden, 1981; Ingram, 1981; Khan et al., 1983; Shriberg and Kwiatkowski, 1980). Although the findings of these studies are preliminary and occur in the presence of wide individual variation, a common set of phonological processes has emerged which frequently characterise the speech of normally developing children aged 2-4 years. These processes are summarised in Table 3.

Table 3: Summary of phonological processes commonly reported in the speech of normally developing children ranging in age from 2 - 4 years

<p><u>SYLLABLE STRUCTURE PROCESSES</u></p> <p><b>Definition:</b> The syllable structure of the target word is simplified usually in the direction of CV syllable shape.</p> <p>Cluster reduction Final consonant deletion Weak syllable deletion Reduplication Epenthesis</p>
<p><u>SUBSTITUTION PROCESSES</u></p> <p><b>Definition:</b> One consonant is replaced by another without reference to neighbouring sounds</p> <p>Stopping of fricatives and affricates Fronting of velars and alveopalatals Gliding of liquids Vocalization Devoicing of final consonants Pre-vocalic voicing</p>
<p><u>ASSIMILATION PROCESSES</u></p> <p><b>Definition:</b> One sound is influenced by another sound in the same word and becomes similar or identical to it</p> <p>Velar assimilation Nasal assimilation Labial assimilation Liquid assimilation</p>

Phonological process analysis has become an attractive alternative to the description of articulation disorders in terms of individual segments, for a number of reasons. Firstly, based on constraints of the oral speech mechanism, phonological processes incorporate both phonetic and phonological aspects of speech sound production. Secondly, current research has identified phonological processes characteristic of normal phonological development (Grunwell, 1981, 1982; Hodson and Paden, 1981; Ingram, 1981; Khan, et al., 1983). These findings provide the clinician with a useful yardstick against which to measure deviant or delayed phonological development as well

as a means of determining the severity of the disorder. Thirdly, process analysis suggests treatment guidelines for expanding the number of phonological contrasts which can be expressed (Hodson and Paden, 1983; Weiner, 1981).

A number of procedures for the assessment of disordered speech sound production in terms of phonological processes have been developed, including those of Hodson (1980), Ingram (1981), Shriberg and Kwiatkowski (1980) and Weiner (1979). The procedures vary in their precise definition of phonological processes, the number of phonological processes investigated and also the manner in which speech samples are elicited. The issues involved in phonological process analysis are dealt with in depth in Chapter 4.

Until recently the description of phonological processes in articulation disorders has been applied to traditionally termed "functional articulation disorders" (Dunn and Davis, 1983; Hodson and Paden, 1981; Ingram, 1976; Schwartz, Leonard, Folger and Wilcox, 1980; Weiner, 1981). In the past five years however, phonological process analysis has been applied to organically related speech sound production disorders where structural or neurophysiological impairment is evident, for example in cerebral palsied individuals (Crary and Comeau, 1981) and apraxic adults (Wolk, 1984).

More recently, two studies have been published (Hodson et al., 1983; Lynch et al., 1983) in which the speech sound production disorders of children with cleft palate are analysed in terms of phonological processes. These studies employed longitudinal designs involving single subjects.

In the study by Hodson et al. (1983), the disordered speech sound production of a five year old unintelligible child with a repaired isolated cleft palate was analysed using Hodson's Assessment of Phonological Processes (1980). Based on the results of this analysis, a remediation programme was implemented to eliminate several

phonological processes. Speech was sampled by having the subject spontaneously name 55 three dimensional stimuli. The percentage of process occurrence was computed drawing on a wide range of possible processes, predetermined for the test stimuli. The predominant processes employed by this subject included cluster reduction, stridency deletion, and velar and liquid deviations, all of which occurred in 100% of opportunities for occurrence. Additional processes employed less frequently included singleton obstruent omissions (pre- and post-vocalic), nasal and glide deviations and glottal and nasal replacement. The processes used are broad in conception and unless the data sample is scrutinised, it is difficult to ascertain the manner in which the processes affect the contrastive function of the various sound classes.

Hodson et al. (1983) did not attempt to speculate on the role played by phonetic factors in relation to the subject's speech production errors. Although the subject's oral mechanism was judged to be adequate and he was stimuable for all consonant sounds, certain of the speech characteristics described seemed to implicate phonetic, in addition to phonological factors, in the development of the disorder in this child. These characteristics include the reported presence of low vocal intensity, glottal articulations and the absence of fricative and affricate productions. Furthermore, velopharyngeal function was assessed during the production of a single sound on a static cephalometric X-ray, which does not provide information about the sphincteric action of the velopharyngeal mechanism during speech.

In the study by Lynch et al. (1983), phonological processes were used as part of a comprehensive analysis of the speech of two children with repaired bilateral cleft lip and palate, at two stages of phonological acquisition. Initial testing was conducted when the subjects were 29 and 37 months of age respectively and re-evaluation took place at 5 and 7 years. In the first evaluation, speech samples

were elicited during free play situations. The Templin-Darley Test of Articulation was administered during the re-evaluation period. Transcribed data were tabulated in a confusion matrix which compared consonants intended with consonants produced.

Three categories of processes were identified using these data: distortion, substitution and deletion processes. The use of the term "distortion" as a phonological process is unusual since distortions, such as lateralisation or hypernasality do not alter the contrastive value of phonemes inherent in Stampe's (1969) original definition of a phonological process. The absence of quantitative percentages of occurrence of phonological processes make it difficult to determine the extent to which phonological processes contributed to the overall picture of the speech disorders in the two subjects.

In contrast to Hodson's study, Lynch et al. (1983) attempted to distinguish errors relating directly to the cleft from those related to phonological disorganisation. They found that while one subject evidenced processes characteristic of normal although delayed phonological development (e.g. cluster reduction, stopping and gliding), the other subject demonstrated a pattern of articulation characteristic of a structural defect (e.g. presence of extensive compensatory articulations, unusually delayed development of labial consonants, and relative absence of patterns characteristic of normally developing children.

Since both studies used small subject samples and were exploratory in nature, generalisability of the findings to the cleft palate population as a whole is limited. Both studies have, however, highlighted the need for additional research applying phonological processes to the speech sound production of children with cleft palate.

### III. DEFINITIONS OF PHONETIC AND PHONOLOGICAL DISORDERS

As mentioned earlier the definition of phonological and phonetic

disability has been, and continues to be, the subject of much controversy. The distinction between a phonetic and phonological disorder forms a central theme in the present study, which attempts to establish the extent to which a linguistically based procedure i.e. phonological process analysis, may be applied to an organic disorder.

Several definitions of phonological and phonetic disorders have been posited, each reflecting the orientation of the particular author. The recurring factor distinguishing phonetic from phonological disorders is the ability of the individual to produce the target segment. It has been suggested that individuals with a phonetic disorder lack the motoric ability to produce particular sounds and may also employ non-standard or distorted articulatory patterns, but the system of phonological contrasts remains intact (Grunwell, 1981, 1982; Shelton and McReynolds, 1979). For example, /s/ may be articulated as [s̪] (dental), as [ʃ] (palatalised) or as [ɬ] (lateralised). As long as the sounds are "s-like", and the neighbouring sounds such as /ʃ/ and /θ/ remain distinct, no essential contrasts have been lost. In contrast, a phonologically impaired child is physically capable of the correct production of all sounds of the language in isolation, but demonstrates an abnormal, inadequate or disorganised system of sound contrasts (Grunwell, 1982; Hawkins, 1985). For example, if /s/ is pronounced as [s] and /θ/ is also pronounced as [s], the s/θ contrast is not achieved and the child will be unable to make "sick" distinct from "thick".

Ingram's (1976) suggestion of redefining articulation disorders in linguistic terms has served to divide researchers into two distinct camps. Representing one view, researchers such as Hodson (1980) and Shriberg and Kwiatkowski (1982) use the term "phonological disorders" in the generic sense, as a cover term for the identification of all disorders of speech sound regardless of their origin. Shriberg and

Kwiatkowski (1982) argue that the domain of phonology encompasses the entire speech production process, ranging from underlying representation through phonological rules and processes to the surface level of production. They further contend that viewing articulation independently of a child's phonemic organisation would circumscribe the disorder to speech production and could lead to inefficient remediation strategies.

Representing the opposing view, Grunwell (1983a), Hewlett (1985), Locke (1983b), Shelton and McReynolds (1979) argue in favour of retaining the term "articulation disorder" as distinct from phonological impairment. They caution against limiting one's view to abstract phonemes in preference to the specifics of speech production and suggest that speech pathologists "should not focus on phonology so sharply that we set aside interest in the learning tools that seem essential to our daily work" (p.9). Dinnsen (1984) concurs with this view and adds that conceiving of phonological disorders as a homogeneous group may result in the clinician missing important information and applying inappropriate treatment procedures.

Hewlett (1985) debates in depth the distinction between phonological and phonetic disorders of speech sound production. Instead of the traditional binary phonetic/phonological distinction, he postulates a three-way distinction in the classification of disordered speech sound production. In his terms, a phonological disorder is one in which an incorrect phoneme is correctly realised, i.e. it is a problem in the selection of the appropriate phoneme. A phonetic disorder is one in which the selection process of the target phoneme is correct, but the "presence of lower level phonetic or articulatory constraints may meet with a 'sympathetic response', so to speak from the phonology" (Hewlett, 1985, p. 162) resulting in the reduction of phonemic contrasts. Articulatory disability forms the third part of the distinction and is defined by Hewlett (1985) as one in which the articulatory characteristics of the speech sounds are maintained,

i.e. there is no loss of phonological contrasts on a productive level. Such disorders may be common in adult patients who have undergone ablative surgery for oral cancer.

In reality, the coexistence of phonological and phonetic disorders is common. Fokes (1982) and Locke (1983b) note that the distinction between phonetic and phonological disorders in children is especially difficult to establish categorically. Fokes (1982) suggests that the "phases of neuromuscular and physical growth are quite interrelated and intertwined with cognitive and linguistic development" (p. 20) and that speech pathologists should acknowledge the close relationship between phonetic and phonological forms.

#### IV. SUMMARY OF THE THEORETICAL FRAMEWORK ADOPTED IN THE PRESENT

##### STUDY

In this study, the theoretical construct of "phonological process" is used to analyse disordered speech sound production in cleft palate children. In addition, a phonological process is defined as a systematic sound change affecting a class of consonant sounds or sound sequences (Edwards, 1983). Phonological processes are used to describe errors on the surface level of production and to establish the extent to which phonemic contrasts are maintained. In the present study, phonological processes are not used to draw inferences concerning the child's underlying representations of the adult phonemic form. Although the possibility of deviant underlying representations is acknowledged, this aspect is not investigated experimentally and no claims are made to support the psychological reality of the processes that are postulated. The primary focus is that of speech sound production. This framework is similar to that employed by authors of several texts (Edwards, 1983; Grunwell, 1982; Hodson, 1980; Stoel-Gammon and Dunn, 1985).

##### V. SUMMARY

This chapter has outlined the clinical applications of three



phonological theories to articulation disordered children in general and to children with cleft palate in particular. The theoretical framework on which the present study is based has been elucidated. In the following chapter, the methodological implications of these theoretical constructs are presented.

#### CHAPTER 4

##### METHODOLOGICAL ISSUES

The application of principles of phonological theory to disordered speech sound production has raised numerous methodological issues of potential significance in phonological assessment. These issues relate primarily to speech sampling and analysis procedures. This chapter highlights some of the major methodological issues involved in phonological process analysis and provides the rationale for and resolutions of these issues for the present study.

As discussed in the previous chapter, the goal of phonological process analysis is to determine the simplification patterns evident in speakers with speech sound production disorders (Ingram, 1976; 1981). The recent publication of numerous procedures for phonological process analysis (Hodson, 1980; Ingram, 1976; 1981; Khan and Lewis, 1984; Shriberg and Kwiatkowski, 1980; Weiner, 1979) has been accompanied by a variety of suggestions for both data collection and analysis, each reflecting the orientation of the authors. The manner in which speech sound production data are obtained and the consequent analysis thereof may have an important effect on the outcome of the analysis (Ingram, 1982; Stoel-Gammon and Dunn, 1985).

#### 1. ISSUES CONCERNING DATA COLLECTION

In order to make a relevant and comprehensive assessment of speech sound production, it is necessary to obtain adequate and appropriate speech samples. Ideally, these should be representative of a speaker's habitual speech production skills in all communication situations. Traditionally, speech has been sampled either by means of the administration of articulation tests or by obtaining samples of conversational speech. Both methods of speech sampling are amenable to phonological process analysis (Ingram, 1976; Khan and Lewis, 1984). However, certain issues, both practical and theoretical, may

impose constraints on how the data are obtained. These issues concern the nature of the speech response (imitated or spontaneous), the range of phonemes sampled, and the method of elicitation (single word or connected speech tasks). Each of these issues is discussed separately.

#### A. Imitated versus spontaneous speech responses

Articulation tests and procedures for phonological process analysis usually elicit imitated or spontaneously produced speech responses to a set of stimuli presented by the examiner, e.g. the Goldman-Fristoe Test of Articulation (Goldman and Fristoe, 1969), the Templin-Darley Test of Articulation (Templin and Darley, 1969), the Arizona Articulation Proficiency Scale (Fudala, 1970), and the Photo Articulation Test (Pendergast, et al., 1969) all elicit spontaneously produced responses. Some articulation tests published for use with children with cleft palate also require spontaneously produced utterances, e.g. Iowa Pressure Articulation Test (Morris et al., 1961). However, certain procedures used to evaluate articulation in cleft palate children require the subject to imitate verbal models provided by the examiner, e.g. the Bzoch Error Pattern Diagnostic Articulation Test (Bzoch, 1979), the Miami Imitative Ability Test (Jacobs, Philips and Harrison, 1970) and the Simulated Sentence Test (Van Demark, 1964). Most phonological process analysis procedures require spontaneously produced responses, such as those of Hodson (1980), Ingram (1981), Shriberg and Kwiatkowski (1980); however, Weiner (1979) elicits single words and sentences by means of delayed imitation.

The question arises as to whether the nature of the speech response reflects the habitual speech sound production of the speaker. Several studies have been conducted to determine whether speech responses obtained through imitation differ from those which are spontaneously elicited. For example, Johnson and Sommers (1978) found fewer articulation errors when responses were imitated than when they were

produced spontaneously. These researchers postulated that the presence of visual and auditory cues provided by the examiner, accounted for the difference between the scores obtained on both tasks. In contrast, Paynter and Bumpas (1977) observed no significant quantitative differences between imitation and spontaneous responses, but noted qualitative differences in the nature of the articulation errors produced.

*The possibility of qualitative or quantitative differences between imitated and spontaneously produced utterances led the present investigator to include only spontaneously produced responses as the more rigorous choice. Imitated responses were excluded from phonological process analysis.*

#### B. The range of phonemes sampled

A second issue concerned the range of speech segments sampled for analysis. Given that the focus of the current investigation is on consonant production, the issue arose as to whether all consonants or only selected consonants, pressure consonants, should be sampled.

*The Iowa Pressure Articulation Test (Morris et al. 1961) and a similarly constructed test for pre-school cleft palate children (Van Demark and Swickard, 1980) aim to assess velopharyngeal incompetence in relation to articulation. These procedures differ from articulation tests for children with functional articulation disorders in that they primarily elicit pressure consonants. Since the aim of the present study is to describe all errors of speech sound production, not only those relating to the production of pressure consonants, all possible English segments were sampled in a variety of phonetic contexts. In addition, phonological processes operate on the relationships between segments within words as well as on the segments themselves. Therefore, by limiting the analysis to the production of pressure consonants alone, it was possible that*

important information would have been overlooked.

#### C. Single word versus connected speech sampling

Concern has been expressed regarding the representativeness of single word naming tasks as opposed to connected speech tasks in the evaluation of children with speech sound production disorders (DuBois and Bernthal, 1978). This applies both to cleft palate children as well as to those with functional articulation disorders. More particularly, the disparity between data obtained from using single word and from connected speech tasks has received attention (DuBois and Bernthal, 1978; Faircloth and Faircloth, 1970). Before the research indicating this discrepancy is reviewed, it seems appropriate to report on the current elicitation methods used in the evaluation of disordered speech sound production.

A number of testing procedures are comprised of single word naming tasks. Single word tasks, such as the Templin-Darley Test of Articulation (Templin and Darley, 1969), the Photo-Articulation Test (Pendergast, Dickey, Selmar and Soder, 1969) and the Assessment of Phonological Processes (Hodson, 1980), usually require subjects to name carefully selected pictures or objects, representing the consonants of English in varying contexts. Some articulation tests, notably the Goldman-Fristoe Test of Articulation (Goldman and Fristoe, 1969) and the Arizona Articulation Proficiency Scale (Fudala, 1970) include story telling sub-tests which supplement the data obtained on the single word tasks. The inclusion of such sub-tests represents an attempt on the part of the test constructors to simulate everyday connected speech. In other speech sampling procedures, especially those on which phonological process analyses are based (Edwards, 1982; Ingram, 1981; Shriberg and Kwiatkowski, 1980), authors advocate the use of connected speech usually obtained from an unstructured free play situation.

*Articulation tests specifically developed for cleft palate children*

(e.g. Bzoch Error Pattern Diagnostic Articulation Test) consist primarily of single word articulation tests, which bear close similarity to those constructed for children with functional articulation disorders. However, as mentioned previously, several researchers (Bzoch, 1979; McWilliams et al., 1984; Morris, 1979) recommend the collection of connected speech samples in addition to the administration of naming tasks. They note that although cleft palate children with marginal velopharyngeal competence may achieve correct speech sound production on single word tasks, they may not be able to maintain this correct production on tasks involving fine and rapid co-ordination of the velopharyngeal mechanism with the oral articulators, as occurs in connected speech.

It has been suggested that single word naming tasks yield different information from procedures involving connected speech. Faircloth and Faircloth (1970) studied the production of single words and the same words in connected speech in a child with an articulation disorder. Their findings revealed large differences when the two conditions were compared. Single word productions were judged to be more intelligible than the same words contained within the connected speech sample. Using a larger sample of articulation disordered children, Dubois and Bernthal (1978) conducted a similar study in which they compared the speech sound production under three conditions: continuous speech in response to pictures, modelled continuous speech in response to a story told by the examiner, and spontaneous picture naming. They observed that the subjects exhibited speech sound errors in the first condition that did not occur in the other two conditions, i.e. there was a qualitative difference in the errors made using different elicitation procedures.

Table 3 contains a summary of the advantages and disadvantages of single word and connected speech tasks. This summary is drawn from several sources, including the opinions of Bankson and Bernthal

(1983), Creaghead and Newman (1985), Grunwell (1980), Ingram (1976), Lund and Duchan (1983), and Shriberg and Kwiatkowski (1980).

Table 4: Advantages and disadvantages of single word tasks and connected speech samples

	ADVANTAGES	DISADVANTAGES
SINGLE WORD TASKS	<p>Single word inventories can be designed to elicit all the phonemes of the language.</p> <p>Single word tasks are quick to administer.</p> <p>The target is known to the examiner which alleviates discarding of unintelligible utterances.</p>	<p>Each word has only a single opportunity to occur.</p> <p>Phonemes are elicited in limited phonetic contexts - initial, medial and final word positions.</p> <p>A preponderance of nouns are elicited as these are easier to represent pictorially than other lexical items. (Shriberg and Kwiatkowski (1980) found that 90-97% of items in five widely used articulation tests involve nouns).</p> <p>The need to elicit all phonemes using stimuli which are easy to represent pictorially may result in complex or unfamiliar words inappropriate for the age of the child.</p>
CONNECTED SPEECH SAMPLES	<p>Connected speech elicited by means of uncontrolled elicitation procedures facilitate the production of a representative repertoire of phonemes under natural conditions.</p> <p>Multiple opportunities for phoneme and word occurrence are possible.</p> <p>Effects of coarticulation can be examined, i.e. the influence of phonetic context on the production of speech segments.</p> <p>A range of lexical types are sampled.</p>	<p>It is sometimes difficult to obtain a representative sample of the child's phonetic repertoire and additional sampling sessions may be required.</p> <p>The examiner may experience difficulty glossing the utterances of highly unintelligible children. In such cases, a percentage of utterances may be "unanalysable".</p>

In the present study, a combination of single word and connected speech elicitation tasks was used as is suggested by Ingram (1981) and Winitz (1969). This was motivated by the clinically well established observation that speech sound errors may be observed in connected speech tasks despite correct production in single word tasks. Furthermore, the likelihood of variability in production of speech sounds in different phonetic contexts, not easily tapped in single word elicitation tasks, could not be ignored.

## II. ISSUES CONCERNING DATA ANALYSIS

The approach to the analysis of speech samples in terms of phonological processes requires careful consideration. Although several analysis procedures (Edwards, 1983; Hodson, 1980; Ingram, 1981; Khan and Lewis, 1984; Shriberg and Kwiatkowski, 1980 and Weiner, 1979) have been developed in recent years and seem similar at face value, "some of them fail to address certain potentially important issues that may affect their usefulness" (Edwards, 1983, p. 351).

In order to analyse the speech samples in terms of phonological processes, however, four interrelated issues were considered. These included the unit of analysis (syllable or word positions), coding of phonetic and phonological errors of speech sound production, criteria for determining the presence of a phonological process and the use of an open or closed set of phonological processes.

### A. The unit of phonological analysis

The selection of the unit of analysis (in terms of the word or syllable) is important in determining the syllable shapes and phonotactic constraints used by speech disordered children. Ingram (1982) draws attention to the fact that this issue is seldom addressed by writers who have published phonological process analysis procedures (Ingram, 1982).

The predominant trend has been to use the word as the unit of



analysis. Researchers and clinicians have identified errors of speech production in terms of whether they occur in word initial, medial or final positions. Although it is relatively simple to determine word initial and word final positions, the medial word position presents some difficulty. For example, the phoneme sequence /kl/ in the word "necklace" would be regarded as a medial consonant cluster if the word was used as the unit of analysis. However, if the syllable was employed, /k/ would function as an arresting phoneme (syllable final or post-vocalically) and /l/ would function as a releasing phoneme (syllable initial or pre-vocalically).

Ingram's (1982) solution to this problem is to employ both the syllable and the word positions, but at different stages of the phonological analysis. In determining the speaker's phonetic inventory, Ingram advocates the use of the word as the unit of analysis and suggests that the syllable is used in phonological process analysis. He differentiates three syllable positions: initial, final and ambisyllabic/ intervocalic positions and provides guidelines for the syllabification of utterances (Ingram, 1981, p. 58).

In contrast to Ingram, Grunwell (1982) has no category for ambisyllabic or intervocalic phonemes. Instead medial singleton consonants are "consistently analysed as the onset of the second syllable, regardless of morphological structure eg. 'rabbit' - CV, CVC; 'painting' - CVC, CVC" (p. 64). Grunwell (1982) cites support for this principle in her study of phonologically disordered children, in which she found that within-word syllable arrests were realised similarly to those in word-final syllables.

In order to ensure a consistent standard across all subjects, it was decided to employ Grunwell's (1982) guidelines for syllabification in the present study. Thus, "medial" consonants were regarded as pre-vocalic or syllable initial consonants. Abutting consonants, such as

/kl/ in the example cited above, were considered as post-vocalic and pre-vocalic, respectively. Within word consonant clusters, for example /sk/ as in "basket", were regarded as occurring pre-vocalically.

#### B. Coding of phonetic and phonological speech sound production errors

A second issue concerns the coding of errors of speech sound production in terms of phonological processes. As was discussed in Chapter 2, cleft palate children frequently show distorted speech sound production; employ compensatory articulations e.g. [ʔ] which cannot be considered as clear distortions, but which are used to substitute for particular classes of sounds, particularly pressure consonants; and demonstrate errors of speech sound production occurring in the speech of normally developing children. In view of the controversy surrounding the definitions of phonetic and phonological errors of production (outlined in Chapter 3), it was considered necessary to establish guidelines which would enable the researcher to code the sampled data accurately and consistently.

The guidelines used were based on the notion of phonological contrastiveness (Hawkins, 1984; Hewlett, 1985). An error of speech sound production was considered a phonetic error, and was not included in the phonological process analysis under the following conditions:

1. if the error did not serve to collapse or merge the phonemic contrast between two or more phonemes. For example, if a subject consistently substituted a voiceless lateral fricative [ɬ] for /s/ and a voiced lateral fricative [ɮ] for /z/, but did not employ this substitution for any other target consonant, the error was considered phonetic. Another example of this type of phonetic error was the substitution of uvular stop [q] for /k/. In such cases the error sound contained the distinctive characteristics of

the target sound and the contrastive value of the target phoneme was not compromised, or

2. if the inability to seal off the oral and nasal cavities directly resulted in a weak or nasally emitted consonant, in which the target was clearly apparent, for example /t<sup>h</sup>/ (weak consonant) or /p̃/ (nasal emission).

An error was considered phonological if the phonemic contrast distinguishing one or more phonemes was collapsed. These errors were included in the phonological process analysis. It is relevant to mention that in such cases, it was possible that a non-English consonant, such as a compensatory articulation (glottal and pharyngeal stops, palatal fricatives, or even laterally released fricatives) fulfilled this criterion. For example, glottal stops may neutralise the place contrast between alveolar and velar stops, and palatal fricatives may neutralise the contrasts between alveolar and alveopalatal fricatives.

In summary, phonetic errors, although recorded for purposes of establishing the subjects' phonetic inventories, were not included in phonological process analysis. Only errors which served to reduce the phonemic contrasts and hence the ability to signal meaning differences between target phonemes were analysed for evidence of phonological processes.

#### C. Criteria for determining the presence of phonological processes

An issue closely related to that of coding the errors of speech sound production concerns the criteria for determining the presence of a phonological process.

Although phonological process analysis has gained considerable popularity in evaluating children with disordered speech sound production, certain writers have expressed reservations regarding its

reliability (Dinnsen, 1984; McReynolds and Elbert 1981; Schwartz, 1983; Weiner, 1984). These authors contend that several published studies have not demonstrated that the sound changes they have attributed to the occurrence of phonological processes are compatible with the theoretical construct of a process, i.e. an adaptation of internal representation to phonetic output. Weiner (1984) suggests that the concept of phonological process has been "overused by some investigators to the extent that all misarticulations are described as *phonological processes*, whether justified or not" (p. 77). Before a sound change can be accurately described in terms of a phonological process, as opposed to a phonetic error, specific criteria, both qualitative and quantitative, should be fulfilled (Dinnsen, 1984; McReynolds and Elbert, 1981).

#### 1. Qualitative criteria

Most authors (Edwards, 1982; Ingram, 1981; McReynolds and Elbert, 1981; Schwartz, 1983) suggest that a phonological process must affect more than a single member of a given class of sounds. For example, if a child produces /t/ for /s/ and does not replace other fricatives with stops, it is insufficient evidence to demonstrate that the phonological process of stopping is operating. A second commonly employed criterion is that the child is able to produce the target sound in at least some contexts, even if the context is incorrect (Grunwell, 1982). In such cases, it is contended that the error form cannot be directly related to surface errors stemming from a structural or physiological impairment.

Other authors, such as Dinnsen, Weismer and Elbert (1979, cited by Weiner, 1984) apply more stringent criteria than those mentioned above. They use phonological processes in the explanatory sense and work on the assumption that in order to substantiate the presence of a phonological process, the child's underlying representation of the adult contrast must be intact and that it is the investigator's responsibility to demonstrate the evidence thereof. Therefore, their

criteria include the following:

- a. The error sound affected by the process must be produced correctly in some contexts.
- b. The consonant must be used contrastively in the context in which it is produced correctly even if the adult contrast is expressed in an unconventional manner.
- c. The process must apply to a limited class of segments, e.g. if only voiceless segments of a class of sounds are affected, the child is aware of the voiced-voiceless distinction within that class of sounds.

The selection of qualitative criteria for the identification of *phonological processes in the present study on cleft palate children* was complicated. In view of the structural and functional impairment of the oral mechanism, it was expected that some of the subjects would be unable to produce certain target sounds correctly, even in *inappropriate contexts*. At the same time, it was also anticipated that some of the errors produced by the subjects were similar to those produced by normally developing children and could be categorised in terms of phonological processes. It was not possible to apply the criteria of Dinnsen et al. (1979, cited by Weiner, 1984) as phonological processes in the present study were used to identify patterns of errors in the descriptive sense and were not used to demonstrate the presence of adult-like underlying representations.

In view of the above, only one qualitative criterion was applied to demonstrate the occurrence of phonological processes in the present study: A phonological process must merge the phonemic contrast of more than a single member of a class of sounds. "Class of sounds" was defined in terms of the major sound classes described according to place, manner and voicing (including voiced and voiceless cognates), as well as phonotactic classes such as the shape or structure of the syllable.

## 2. Quantitative criteria

According to McReynolds and Elbert (1981), a single occurrence of an error sound can not be considered as strong evidence that a process is operating. They suggest that the greater the number of instances in which a particular pattern can be identified, the stronger the empirical evidence that the phenomenon observed could be a process. Perusal of the literature reveals a lack of consensus among researchers regarding the frequency with which a sound change must occur before it can be reliably regarded as a phonological process.

A number of quantitative criteria have been suggested which are based on a percentage computed in terms of the number of times a process occurs (frequency) in relation to the number of times the process could have occurred (opportunity):

a. McReynolds and Elbert (1981) suggested the following quantitative criteria to ensure the reliability of phonological process occurrence:

i. the error had to have the opportunity of occurring in at least four instances, and

ii. the error had to occur in at least 20% of items that could be affected by the process.

b. Khan and Lewis (1984) defined a productive process as one which occurred in more than 60% of available opportunities.

c. Ingram (1981) does not specify quantitative criteria for determining the presence of a phonological process, but only includes those processes which are applied in more than 50% of possible occurrences, in his summary of the most productive phonological processes.

In the present study, the quantitative criteria adopted were those of McReynolds and Elbert (1981), i.e. the error had to occur in 20% of possible items and each process had to have the opportunity to occur

at least four times in the sample. These criteria were selected in preference to those recommended by Hodson (1980), Ingram (1981) or Khan and Lewis (1984) as the subjects of the study were four years of age, by which stage the majority of processes in normally developing children would be suppressed. It was felt that selection of a higher percentage frequency of occurrence than 20% might have resulted in the elimination of important process information.

In summary, therefore, the identification of phonological processes was dependent on the fulfilment of both qualitative and quantitative criteria, i.e. processes had to affect more than a single member of a sound class and had to occur in at least 20% of items in which the process could apply. It was assumed that such criteria would serve to increase the reliability of the phonological process analysis, in that misarticulations due to chance factors, e.g. inadvertent transcription errors or single instances of misarticulations, such as slips of the tongue or "articulatory mistakes", were not inappropriately described in terms of phonological processes.

#### D. Closed versus open set of phonological processes

Phonological process analysis procedures vary in terms of the number of processes assessed. Some procedures (Hodson, 1980; Khan and Lewis, 1984; Shriberg and Kwiatkowski, 1980; Weiner, 1979) determine the occurrence of a limited number of processes (a closed set). The number of processes assessed ranges from eight processes (Shriberg and Kwiatkowski, 1980) to 42 processes (Hodson, 1980). The rationale for including a limited set of processes varies among the authors. For example, Shriberg and Kwiatkowski (1980) assess just eight "natural processes", i.e. those which "accomplish simplification and the sound change must be widely attested in natural language data" (p. 10). Hodson (1980) and Khan and Lewis (1984) assess 42 and 14 processes respectively, based on the opportunities for processes to occur in specific test items. Most researchers, however, encourage the examiner to scrutinise the data for additional patterns not

directly assessed in their procedures.

Other authors (Edwards, 1983; Grunwell, 1982; Ingram, 1981; Stoel-Gammon and Dunn, 1985) employ an open-set of processes. In other words, the examiner is not required to determine the presence of a specific set of processes, but should examine the data to determine all possible processes which are applied. These authors reason that at the present time, insufficient data are available regarding the range of possible processes, and that by limiting the analysis to specific "test" processes it is possible to overlook important information, such as idiosyncratic processes or those uncommon in children with disordered speech (Edwards, 1983; Ingram, 1981).

The fact that the application of phonological process analysis in children with cleft palate is relatively unexplored, led the present researcher to employ an open set of processes in the analysis of speech sound production.

### III. PHONOLOGICAL PERCEPTION AND PHONOLOGICAL PRODUCTION

A further issue in constructing a methodology to describe the phonological systems of speech disordered children is whether or not to assess phonological perception, and the most appropriate methodology for the assessment thereof. Phonological or phonemic perception is defined by Barton (1980) as the "classification of speech into minimal units which signify meaning differences" (p. 97).

Although several authors (Barton, 1980; Crystal, 1981; Locke, 1980ab; Straight, 1980) have made reference to phonemic perception and its relationship to phonological production, studies of disordered child phonology, in the main, are limited exclusively to descriptions of phonological production. Perhaps this is due to the fact that the mechanisms of phonemic perception are less understood than those of production and because phonological perception is relatively inaccessible to scientific investigation (Yeni-Komshian and Ferguson,



1980). Nonetheless, Locke (1979) has stressed that

If there is a question as to the extent of a child's phonological knowledge, it cannot be answered by observing him only as a producer of language. This is so because the child's phonological knowledge is not fully expressible with his characteristically underdeveloped vocal tract and motor system. To limit oneself to the child's actual utterances, so constrained, is to obtain a conservative picture of his knowledge of phonological units and rules (p. 88).

In view of the above observation, assessment of the subjects' phonemic perception was included as a component of the phonological analysis procedure in the present study. The question arose as to the most appropriate methodology to assess phonemic perception which would yield valid and reliable results.

Several tests of phonemic perception, also referred to as auditory discrimination, have been published. These include the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (Goldman, Fristoe and Woodcock, 1970), the Boston University Speech Sound Discrimination Test (Pronovost and Dumbleton, 1953), Auditory Discrimination Test (Wepman, 1958), The Test of Auditory Discrimination (Templin, 1957), among others. Although several of these tests and procedures have been widely employed in the clinical situation, they have recently been criticised in terms of their validity (Locke, 1980ab; Strange and Broen, 1980). The limitations of these tests can be divided into task variables and stimulus variables. Each of these are briefly outlined:

#### 1. Task variables

According to Locke (1980a) two paradigms have been used to assess phonemic perception: the discrimination paradigm (in which the subject must compare two physically present stimuli and report whether they are the "same" or "different") and the identification paradigm (in which the subject must compare the presented stimulus with an absent standard or internal representation). The limitations of these procedures primarily concern the accuracy of the responses. For example, in the discrimination paradigm, a failure to respond may

relate to a lack of understanding of the meaning of "same" versus "different", or overloading of the auditory memory which is unable to store the stimuli long enough for the subject to make a judgement. In the identification paradigm, which usually comprises a picture identification task, the subject need not conduct a search of all the pictures in order to make a choice. He need only look for something that might be represented by the label he hears. Common to both paradigms is the increased risk of chance responses which imposes threats on the validity of the responses (Locke, 1980b).

## 2. Stimulus variables

Stimuli employed for speech sound discrimination tests usually comprise series of minimal pairs which are represented verbally by the examiner or in picture form. In both cases, attempts are made to remove visual cues, which may influence the response.

The chief limitation of published procedures for the assessment of speech sound discrimination relates to the fact that all are procedures of interpersonal discrimination and do not assess the subject's ability to discriminate on an intrapersonal level. Locke (1980a) presents a thorough critical evaluation of the stimuli used in four available tests for speech sound discrimination, i.e. The Auditory Discrimination Test (Wepman, 1958) the Templin Test of Auditory Discrimination (Templin, 1957), the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (Goldman et al. 1970), and the Boston University Speech Sound Discrimination Picture Test (Pronovost and Dumbleton, 1953). He compared the contrasts contained in these four tests with the most common phonemic confusions made by children (based on the work of Snow, 1963) and concluded that only 6 of the 36 most common confusions are tapped by the above four tests. Thus, these tests only assess a child's interpersonal discrimination and do not evaluate the internal phonological organisation or intrapersonal discrimination abilities.

The above discussion has highlighted some of the methodological issues involved in the assessment of speech sound discrimination. In summary, a test was required which would assess the subjects' intrapersonal auditory discrimination in a variety of phonetic contexts. Furthermore, a response format was required which was easy for the subject to understand and which would eliminate as far as possible the occurrence of chance responses. The Speech-Production-Perception Test developed by Locke (1980b) fulfilled these criteria and is described in detail in Chapter 5.

#### IV. SUMMARY

The present chapter has addressed some of the major issues involved in conducting phonological process analysis. Particular reference was made to issues of data collection and analysis in relation to the study of disordered speech in cleft palate children. In addition, the methodological issues involved in the assessment of phonemic perception were considered. Resolution of these issues formed the foundation upon which the methodology (discussed in Chapter 5) of the present study was formulated.

## CHAPTER 5

### METHODOLOGY

In this chapter, the aims of the study are specified, the participating subjects are described and the procedures followed for the collection and analysis of data are outlined.

#### I. AIM

The aim of the study was to describe the speech sound production errors in children with cleft palate in terms of phonological processes.

#### II. RESEARCH DESIGN

The research design of the study constitutes a combination of small-group research and individual case description. While such a design precludes the possibility of making universal statements on the basis of the data presented in this report alone, its value lies in the detailed analyses of speech production patterns. The design employed permitted the researcher to examine inter-subject differences and similarities in speech production performance and to determine tentative group trends with regard to phonological process usage.

Both theoretical and practical considerations determined the research design adopted in the present study. In the past, investigators have attempted to establish commonalities of speech production both in speech disordered children with cleft palate and in normally developing non-cleft palate children. Although there is obvious value in the search for general trends, large cross-sectional studies tend to neutralise important individual differences. The recognition of the limitation of large group studies combined with the growing awareness of wide individual variation in phonological acquisition, has led researchers in the area of child phonology to opt for in-depth phonological analyses on small groups of children where  $N = 5$  to 10 subjects (Dunn and Davis, 1983; Grunwell, 1981; Leonard,

Newhoff and Mesalam, 1980; Stoel-Gammon and Cooper, 1984, among others). These researchers have underscored the fact that speech disordered children, in general, are a heterogeneous population and that recognition of individual variation may lead to a greater understanding of phonological acquisition and hence provide clues for effective remediation. Thus, small group research reflects the current trend regarding phonological analysis of speech disordered children.

Practical limitations (such as time resources and subject availability) mitigated against the inclusion of a larger sample size than that which comprised the present study. During the period in which the study was conducted, only eight subjects fulfilled the criteria for subject selection.

### III. SUBJECTS

#### A. Criteria for the selection of subjects

Potential subjects were drawn from the case loads of speech therapists in several clinical settings. All potential subjects were enrolled for regular speech therapy. In the discussion below, reference is made to "the child's speech therapist". This refers to a graduate speech therapist who was responsible for the child's regular speech therapy.

The following criteria for subject selection are presented in order of priority:

1. Age: - Subjects were required to fall in the age range 4.0 - 5.0 years. The lower limit of 4.0 years was selected to ensure that the errors observed could be characterised as "true errors" of pronunciation and did not reflect normal maturation processes. The results of several cross-sectional large group studies have indicated that by age 4.0 years, most normally developing children pronounce the majority of English consonants correctly (Crystal et al. 1976; Prather,

Hedrick and Kern, 1975; Sander, 1972). The upper limit of 5.0 was selected as it was likely that after age 5.0 the errors that did occur would be simple articulation errors, such as distortions of the target sound, rather than a reduction in phonemic contrast. Furthermore, owing to the relatively small sample size, it was assumed that more meaningful inter-subject comparisons would be possible if critical variables were held as constant as possible, and the age factor could be controlled.

2. Cleft type: Cleft type was limited to clefts of the lip and palate or cleft of the palate only (hard and/or soft palate). The critical factor was a cleft of the soft palate, as it is the resulting impaired velopharyngeal function which accounts for most of the variability in speech sound production in children with cleft palate (Bzoch, 1979; Fletcher, 1978; Moll 1968; Morris, 1968; Spiersbach et al., 1961).

Potential subjects with isolated cleft lip involvement were excluded because of the customary absence of articulation errors associated with this condition (McWilliams et al., 1984; Ross and Johnston, 1972). Children with sub-mucous cleft palate were also excluded from the study. Owing to its occult nature, this condition may escape diagnosis until age 2 or 3 years (McWilliams et al., 1984). Frequently no surgical repair is undertaken unless interference with speech development is observed. Hence the difference in terms of surgical intervention between sub-mucous and overt cleft palate was considered too large to warrant inclusion of the former group.

3. Surgical management: Primary surgical repair was to have been completed by the time of testing. This criterion was introduced in order to account, as far as possible, for articulation errors directly attributable to the unrepaired cleft, inter alia, weak consonant articulation and audible nasal emission.

4. Speech sound production skills: Subjects were to have been diagnosed as having multiple errors of speech sound production by child's speech therapist. For the purposes of the present study, this implied that the errors had to affect the production of several consonants, consonant clusters or classes of consonants. To ensure this criterion, discussion with the speech therapist involved had to reveal that the child was unintelligible to unfamiliar listeners. Errors of speech production could involve omission, substitution or distortion of the target sound. However, subjects with simple developmental substitutions involving only one or two sounds, e.g. /θ/ for /s/ or /w/ for /r/ were excluded, as it was felt that these errors alone would not be sufficient to constitute a phonological disability.

5. Previous speech therapy: The effects of speech therapy on speech and language development could not be accurately determined because of the early involvement of the speech therapist in the habilitation process in all potential subjects. Subjects were selected whose remediation programme (described by the child's speech therapist) focused on traditional methods of therapy for cleft palate children, i.e. exercises for the improvement of velopharyngeal functioning and articulation therapy using a single sound approach (Morley, 1971; Wells, 1971). Potential subjects whose remediation goals were the suppression of phonological processes or the increase of the systems of phonemic contrasts were not included in the study.

6. Language skills: As assessed by the child's speech therapist, potential subjects were to have sufficiently developed receptive and expressive language abilities to understand the instructions in the test situation. Furthermore, the subject was to be capable of providing a spontaneous speech sample which comprised utterances which averaged at least six words in length. Given the frequent occurrence of developmental language delay associated with children with cleft palate (Shames and Rubin, 1979), more stringent criteria

for language skills could not be specified. Furthermore, the focus of the study was at the level of speech sound production and did not aim to assess the relationship of phonology to other levels of language functioning.

7. Associated abnormalities: No evidence of gross mental retardation or intellectual impairment was to be detectable as it was felt that in such cases, errors of speech production may be due to factors unrelated to the cleft itself. In addition, subjects whose cleft palate was but one of a constellation of abnormal features, as in the case of a syndrome (e.g. Apert's syndrome, Crouzon's disease) were not considered for inclusion in the study.

8. Presence of developmental apraxia or dysarthria: Potential subjects who showed overt signs of developmental apraxia or dysarthria were not included in the present study. The child's speech therapist was questioned as to the presence in the subjects of signs such as groping trial and error behaviour, highly inconsistent articulation errors in speech production, repetitions and prolongations of speech sounds, errors in the production of vowels and consonants, incorrect sequencing of sounds on diadochokinetic tasks, prosodic disturbances, e.g. slow speech rate or monotony. These features have been reported as characteristic of children with developmental apraxia or dysarthria (Jaffe, 1984). Potential subjects who showed combinations of these features were excluded from the study as it was assumed that such conditions could have affected the speech sound production differently from those of a cleft palate only.

9. Hearing: The results of pure tone air conduction audiometry had to reveal normal bilateral hearing screened at 25dB HL in the frequencies 500, 1000, 2000, 4000 and 6000 Hz (after Harrison and Phillips, 1976) at the time of the study. Such hearing levels would permit the subject to hear the experimenter during the testing



procedure.

It is recognised that the occurrence of otitis media and resultant conductive hearing loss is a frequent correlate of the cleft palate condition (see Chapter 2). However, its capricious nature together with the frequent occurrence of subclinical pathology (Walton, 1973) precluded detailed documentation. The fact that fluctuating hearing levels may have negatively influenced the development of speech and language skills could not be ruled out.

If the potential candidate fulfilled the other criteria for subject selection, pure tone air conduction hearing screening was conducted by the experimenter the day prior to the experimental procedure. Testing was carried out in a sound treated room using a Madsen OB 40 diagnostic audiometer calibrated to ISO (1964) standards. The subject was conditioned through earphones to respond to the pure tones presented at 25db HL while engaging in a play activity. Potential candidates who failed the hearing screening procedure were not included in the subject sample.

10. Home language: Only English speaking subjects from monolingual families were included as English phonemic analysis procedures were employed in the study.

Thus, the major criteria for subject selection were that the child had to be English speaking and four years old with a repaired cleft involving the soft palate. In addition, he/she had to be diagnosed as having a multiple articulation disorder. While additional variables such as position of the child in the family, sex, psychosocial adjustment and socioeconomic factors may affect speech and language development, it is particularly difficult to control for these.

#### B. Description of subjects

Eight subjects, four male and four female, were selected in the age range 4.0-5.0 years. The subjects were derived from the Speech and

Hearing Clinic of the University of the Witwatersrand, Johannesburg, the Speech Therapy and Audiology Department of the Johannesburg Hospital and from speech clinicians in private practice in the Transvaal. All subjects had undergone primary lip and palatal repair by the time of testing. The distribution of cleft type among the subjects was as follows:

- 3 complete unilateral clefts of the lip, alveolus, hard and soft palates (2 male and 1 female)
- 2 complete bilateral clefts of the lip, alveolus, hard and soft palates (1 male and 1 female)
- 2 incomplete clefts of the hard palate extending from the incisive foramen to the soft palate (1 male and 1 female)
- 1 isolated cleft of the soft palate only (female).

Detailed subject description was derived from two sources. The first comprised a case history questionnaire devised by the experimenter. The second source was a description of the structure and functioning of the subjects' oral mechanisms, based on a subjective examination conducted by the experimenter, discussed below.

#### 1. Case history information

The case history form was completed by each subject's mother prior to the testing procedure. (A copy of the case history form is provided in Appendix A). This information was supplemented where possible through consultation with the subject's speech therapist, the plastic surgeon involved, or from case records where available. The case history form was accompanied by a covering letter describing the purpose and procedure of the experimental tasks and requesting formal consent for participation in the study. Table 5 contains a detailed summary of the clinical characteristics of individual subjects, based on the case history information.

Table 5: Summary of description of subjects

SUBJECT	SEX	AGE AT SURGERY (IN YEARS)	CLEFT TYPE	AGE AT SURGERY (IN MONTHS)	HISTORY OF INFECTION OR DISEASE	HISTORY OF HEARING LOSS	ONSET OF SILENT DEAFNESS (IN MONTHS)
UJ	M	4,0	Complete left unilateral cleft of lip, alveolus, hard & soft palate	Lip (3 months), hard and soft palate (9 months)	None reported	None reported	9 months
CS	M	5,0	Complete bilateral cleft of lip, alveolus, hard & soft palate	Lip (5 months), hard and soft palate (18 months)	Twice annually P.E. tubes inserted twice	Mild hearing loss for duration of 2-3 days	24 months (intermittent therapy)
JM	M	4,9	Incomplete cleft of hard palate incisive foramen to soft palate	Hard and soft palate (10 months)	Occasional episodes of otitis media, P.E. tubes inserted twice	Occasional loss of hearing of short duration	12 months (intermittent therapy)
P	F	4,11	Incomplete cleft of hard palate extending from incisive foramen to soft palate	Soft palate (14 months), hard and soft palate (16 months)	Numerous episodes of otitis media, anti-biotic therapy only	Mild to moderate hearing loss lasting from 2-3 days to 3 weeks	24 months (intermittent therapy)
DOS	F	4,10	Complete bilateral cleft of lip, alveolus, hard & soft palate	Lip (4 months), hard and soft palate (12 months)	None reported	None reported	12 months (intermittent therapy)
LC	F	4,1	Complete left unilateral cleft of lip, alveolus, hard & soft palate	Lip (3 months), hard and soft palate (12 months), hard and soft palate (15 months)	Twice annually P.E. tubes inserted twice, antibiotic therapy only	Mild hearing loss for duration of 2-3 days	18 months
SS	F	4,2	Incomplete cleft of soft palate	Soft palate (10 months)	On two occasions P.E. tubes inserted on both occasions	Mild hearing loss for duration of infection	8 weeks (intermittent therapy)
SM	F	4,6	Complete left unilateral cleft of lip, alveolus, hard & soft palate	Lip (4 months), hard and soft palate (36 months)	None reported	None reported	12 months

Table 5: Summary of description of subjects

SUBJECT	SEX	AGE AT TESTING (IN YEARS)	CLEFT TYPE	AGE AT SURGERY (IN MONTHS)	HISTORY OF MIDDLE EAR DISEASE	HISTORY OF HEARING LOSS	DURATION OF SPEECH THERAPY (IN MONTHS)
TJ	M	4,0	Complete left unilateral cleft of lip, alveolus,	Lip (3 months) Hard and soft palate (9 months)	None reported	None reported	9 months
CS	M	5,0	Complete bilateral cleft of lip, alveolus, hard & soft palate	Lip (5 months) Hard and soft palate (18 months)	Twice annually P.E. tubes inserted twice	Mild hearing loss of a few days duration	24 months (intermittent therapy)
JM	M	4,9	Incomplete cleft of hard palate extending from incisive foramen to soft palate	Hard and soft palate (10 months)	Occasional episodes of otitis media. P.E. tubes inserted twice	Occasional loss of hearing of short duration	12 months (intermittent therapy)
BS	F	4,11	Incomplete cleft of hard palate extending from incisive foramen to soft palate	Soft palate (11 months) Hard palate (35 months)	Numerous episodes (x/- 6 annually) Anti-biotic therapy only	Mild to moderate hearing loss lasting from 2-3 days to 3 weeks	24 months (language therapy)
ChS	F	4,10	Complete bilateral cleft of lip, alveolus, hard & soft palates	Lip (4 months) Hard & soft palate (12 months)	None reported	None reported	12 months (intermittent therapy)
LC	F	4,1	Complete left unilateral cleft of lip, alveolus, hard & soft palate	Lip (3 months) Soft palate (12 months) Hard palate (45 months)	Twice annually Anti-neptic treatment only	Mild hearing loss of a few days duration	18 months
SS	F	4,2	Incomplete cleft of soft palate	Soft palate (10 months)	On two occasions P.E. tubes inserted on both occasions	Mild hearing loss for duration of infection	8 months (intermittent therapy)
GH	F	4,6	Complete left unilateral cleft of lip, alveolus, hard & soft palate	Lip (4 months) Hard & soft palate (36 months)	None reported	None reported	12 months

## 2. Description of the status of the oral mechanism

A checklist, requiring yes/no responses or brief descriptions, for the screening examination of oral structure and function was devised and filled out by the experimenter (Appendix B). Items included in the checklist, were drawn from the work of Trost (1983), Van Hattum (1974) and from the Oral Speech Mechanism Screening Examination (St. Louis and Ruscello, 1981). Subjective observations of oral structure and functioning were made by the experimenter, using a torch and tongue depressor to aid observation. No attempts were made to quantify such aspects as the degree of malocclusion or the competence of the velopharyngeal mechanism. Furthermore, no instrumental examinations of oral functioning (such as videofluoroscopy or fiberoptic nasendoscopy) were conducted. Had the purpose of the present study been to correlate the speech production skills with oral structure and functioning, such information would have been necessary. However, the intention of the study was to describe patterns of speech production and while results of objective assessments of oral functioning would have been of additional interest, the experimenter's subjective impressions were deemed sufficient. The results of the examination of oral structure and function were drawn upon in the analysis of speech sound production patterns.

Table 6 below, contains a summary of the findings of the examination of the structural and functional characteristics of the subjects' oral mechanisms. Two additional points, not presented in table 6 deserve clarification. Firstly, the oronasal fistulae in ChS, LC and GH were small, elongated fistulae of approximately 5mm x 3mm and were located at the incisive foramen. Secondly, no overt velar movement was noted in five subjects in the production /a/. It is stressed that no conclusions regarding the adequacy of velopharyngeal function on the basis of this observation are possible, since posterior or lateral pharyngeal wall movement could not be observed.

**Table 6: Summary of the oral structural and functional characteristics for individual subjects based on the findings of the examination of the oral speech mechanism**

[illegible]

\*\* Indicates severe  
 # Norms according to Frost (1983)  
 CHT Could Not Test, as some subjects

#### IV. DATA COLLECTION

This section describes the methods used to elicit the speech samples and the procedures for recording and transcribing the data. The procedure used for the assessment of phonemic perception is also described. The methodology of data collection employed in the present study is based on careful consideration of the relevant issues discussed in Chapter 4.

##### A. Assessment of speech production

##### 1. Methods of elicitation of the speech samples

The primary objective in obtaining a sample of speech for phonological analysis is to ensure that the data obtained are representative of the child's habitual speech patterns. Two independent yet supplementary speech elicitation tasks were constructed. The first was a spontaneous object naming task, and the second comprised a structured connected speech task. This combination of speech elicitation procedures was employed for the reasons discussed in Chapter 4, and reflects the approach advocated by several researchers in their work with non-cleft palate phonologically disordered children (Edwards, 1980; Fokes, 1982; Ingram, 1981; Maxwell and Rockman, 1984). This approach has added relevance in children with cleft palate as research and clinical experience have repeatedly shown that many children with cleft palate can produce isolated consonants or single words more correctly than connected speech. This phenomenon is explained by the fact that the speech mechanism functions more efficiently at a slower rate than it does under the demands of connected speech (Air and Wood, 1985; Darley, 1978; Edwards, 1980; Morris, 1968, among others).

The following section describes the tasks in detail as well as the procedures employed for their administration.

##### a. Naming task

The naming task was composed of 86 stimulus words, 39 of which were

drawn from the stimuli contained in Hodson's Assessment of Phonological Processes (1980). These stimuli were included for a number of reasons. Firstly, Hodson's (1980) items are suited to the vocabulary of the pre-school child (p. i). Secondly, a representative sample of English consonants is sampled in a controlled, organised and economical fashion; and thirdly, responses are elicited by means of object naming which has, in the present writer's opinion, the potential to capture the interest of four-year old children for a longer period than would a picture naming task.

Hodson's (1980) procedure contains 55 stimulus items. Sixteen of these items were excluded from the present naming task either because they were peculiar to American English, e.g. "jump rope", "zipper", "quarter" or because they were felt to be unfamiliar words to preschool South African English speaking children, e.g. "ice cubes", "Santa Claus", "sled", "music box". These stimuli were replaced by words selected by the writer which were considered more familiar to the subjects. The phonetic characteristics of the excluded items were incorporated into the selection of the replacement stimuli. As far as possible, an attempt was made to conserve the number of items, bearing in mind the possibility of fatigue and reduced attention span in the subjects. A list of the stimulus items comprising the naming task is contained in Appendix C.

#### 1. Construction of the naming task

The construction of this task resembled that of Hodson (1980). All South African English singleton consonants were sampled at least twice in syllable initial and syllable final positions. Phonemes were classified according to their syllable positions and not their orthographic positions as the syllable was used as the unit of analysis as advocated by Ingram (1981). (See Chapter 4 where this issue was discussed). In accordance with the phonotactic rules of English (Sloat, Taylor and Hoard, 1978), the consonants [h, w, j] were sampled only in syllable initial position; [ŋ and ʒ] may not



occur in word initial position, although they can be elicited in within-word syllable initial position, e.g. "hanger" and "television". In addition, South African English is an "r-less" dialect which limits the occurrence of /r/ to syllable initial positions only (Lanham, 1967).

Thirty consonant clusters (26 two-element clusters and 4 three-element clusters) were each sampled at least twice. Twenty-one clusters occurred in syllable initial position with only 9 syllable final clusters. This disparity is accounted for by the fact that syllable final clusters are frequently the result of morphological endings (the past tense morpheme, realised as [consonant + d] or [consonant + t] or the plural morpheme, realised at the phonetic level as [consonant + z] or [consonant + s]). These morphological endings affect the production of nouns or verbs (Ingram, 1976). Since the majority of the stimulus items consisted of singular nouns, the opportunity for the occurrence of syllable final clusters was limited.

Phonemes were sampled in a variety of phonetic contexts to determine variability in speech sound production (Edwards, 1983; Schwartz et al., 1983). The characteristics of preceding and following vowels were varied and an attempt was made to ensure a range of syllable shapes, defined as "the sequence of consonants and vowels within the syllable", (Shriberg and Kwiatkowski, 1980 p.6). In addition, the canonical shape of stimulus words was varied, i.e. "the sequence of syllables as they combine to form a word" (Shriberg and Kwiatkowski, 1980, p. 6). Monosyllabic words comprised 66% of the stimuli, 25% were bisyllabic words and 8% were polysyllabic words.

A series of 79 three-dimensional objects and toys was assembled by the examiner to elicit the 86 stimulus items. Some objects served to elicit multiple stimuli, e.g. a face elicited "nose" and

"mouth". Where object representation was not possible, pictures were used, e.g. "swimming pool", "thin". Five of the items could not be directly represented by an object and thus required some prompting in order to elicit the desired response. This was accomplished using a sentence-completion format, e.g. for the stimulus "thin", the subject was presented with two pictures of two men, one thin and one fat. The examiner said, "This man is fat and this man is \_\_\_\_". The subject was required to complete the sentence.

ii. Procedure for the administration of the naming task

The naming task was administered to each subject in a single session which varied from between 45 - 60 minutes duration. Testing took place in a small sound-treated room in the Speech and Hearing Clinic at the University of the Witwatersrand. The subject sat opposite the examiner at a small, padded table. The stimuli were located in a box alongside the subject. A second empty box was placed adjacent to the box containing the stimuli. The subject was instructed as follows:

Choose a toy and say its name loud and clear and then put it in the empty box.

The subject selected the stimuli randomly from the box one at a time. If the subject was uncertain of the name of the object, its name was provided by the experimenter. The object was placed to one side, and the subject was required to name the object a second time after the entire task had been completed. In this way, speech production by direct imitation was avoided. Short breaks were provided after approximately 15 items if the subject showed signs of fatigue. Tangible reinforcements in the form of stars or stickers were given to the subject at irregular intervals to maintain attention and motivation.

b. Connected speech task

The connected speech task took the form of a structured picture

description task which supplemented the responses obtained in the naming task. The same stimulus words contained in the naming task were used to construct the stimuli for the connected speech task. Besides the previously mentioned advantages of obtaining connected speech samples (see p. 59), this task provided a means of comparison between phonemes produced in single words and those produced in the same words in connected speech.

i. Construction of the connected speech task

A structured picture description task was selected as it provides the examiner with a reference, which facilitates glossing the utterance (Deputy and Ross, 1982). It is a more complicated task than a single-word naming task and therefore encourages children to use longer sentences and more complex language (Deputy and Ross, 1982). The task is familiar to preschool children as it is a common requirement to have them describe pictures (Dubois and Bernthal, 1978; Lund and Duchan, 1983).

A series of 67 pictures was created by a commercial artist, in which the 86 stimuli employed in the naming task were depicted in novel situations e.g. a pig riding a bicycle. The pictures comprised clear, colourful line drawings which were pasted onto cards measuring 20 x 15 cm. It was hoped that the selection of novel or unusual situations in preference to conventional action pictures would elicit spontaneous responses and would maintain the subjects' interest in the task. In an attempt to conserve the length of the task, several pictures contained more than one stimulus word e.g. a boy opening a "door" with a "fork".

In order to ensure that the stimuli would be easily discernible by the subjects and that the pictures would provide the responses they were designed to elicit, a preliminary set of pictures was created. These were presented to 30 four year old children from monolingual English homes with no known communication problems. These children

were selected according to their age from two middle-income area nursery schools. The testing procedure took place in a quiet room at the nursery schools. As in the procedure for the naming and connected speech tasks, the children were seated at a small table opposite the present researcher. Each child (15 males and 15 females) were instructed as follows:

I am going to show you some funny pictures. I want you to look carefully at the pictures and then tell me what is happening in the picture.

Responses to stimulus pictures were written orthographically on a form devised for this purpose. A picture was selected for inclusion in the experimental connected speech task if it was correctly identified by 80% of the children. Seven of the original 67 pictures failed to meet this criterion. Maintaining the same target words, these seven pictures were thus reconstituted, redrawn and were presented again to the same children until all the stimuli reached the specified criterion.

ii. Procedure for the administration of the connected speech task

The connected speech task was administered approximately four days, but no longer than one week, after the recording of the naming task. This interval was considered sufficiently short to avoid the possibility of change in speech sound production skills due to phonological development. As with the naming task, the connected speech task took place in a sound-treated room in the Speech and Hearing Clinic at the University of the Witwatersrand. The length of each sampling session was approximately 60 minutes.

The picture cards were presented, in no predetermined order, one at a time to the subject, who was seated at a small table opposite the examiner. The instructions to the subject were the same as those used in the standardisation procedure, described above. On occasion, a certain amount of probing was necessary to elicit a connected utterance. If prompting was not fruitful, a description

containing the word required was provided by the experimenter and the item was readministered at the completion of the task. Although these items could be regarded as a form of imitated response, the time interval between the two administrations was considered too long to influence the reliability of the speech sound production.

In order to maintain the subjects' interest, concrete reinforcement, in the form of stars, was given to the subjects at irregular intervals. In addition, short breaks of a few minutes were provided when the subjects showed signs of reduced attention or fatigue.

## 2. Recording the data

The accuracy of phonological analysis is dependent on the fastidiousness of the phonetic transcription (Shriberg and Kent, 1982; Stoel-Gammon and Dunn, 1985). In the case of speech of cleft palate subjects, keen discrimination of both phonetic and phonemic substitutions is required of the listener. Therefore, high quality tape recordings were considered crucial. The methods used to record the speech samples were borrowed from the suggestions made by Allen (1983), Ingram (1976), Shriberg and Kent (1982) and Shriberg and Kwiatkowski (1980).

All speech samples were recorded on a Uher 4000 Report IC reel-to-reel audio-tape recorder. This tape recorder had the added facility of variable speed settings which enabled the listener to play back the recording at slower speeds. This facility was used to determine the ambiguous place of articulation or voicing characteristics of the utterances.

Speech samples were recorded in a quiet sound-treated room, with minimal reverberation to ensure that recordings were uncontaminated by background noise. In addition, the surface of the table at which the testing took place was padded, thus minimising the noise of dropping toys, etc. A Uher M517 low impedance omnidirectional microphone

was placed in a stand on a second table approximately 25-30 cm from the subject's mouth. Pretesting was conducted before each sampling session to ascertain the sensitivity of the recording level.

To aid the transcription and analysis process, the experimenter glossed the subject's utterance immediately after it was produced, taking care that no part of the subject's utterance was lost. Glossing is defined as the exact repetition of the subject's intended form, including fast casual speech items and ungrammatical phrases (Shriberg and Kwiatkowski, 1980).

### 3. Phonetic transcription

The process of phonetic transcription requires the observer to make a judgement about a segment of speech he perceives (Ingram, 1976). Because phonetic transcription is subjective, observer bias, variability and error are possible (Ingram, 1976; Shriberg and Kent, 1982). This may be exacerbated further in the transcription of disordered speech in children with cleft palate, especially where distortions and subtle deviations are often the rule rather than the exception. In order to increase the accuracy of transcriptions, two observers transcribed the speech samples. The use of multiple transcribers has been recommended by several authors (Edwards, 1982; Ingram, 1976; Grunwell, 1981; Shriberg and Kent, 1982; Stoel-Gammon and Dunn, 1985). However, the great investment of time in the transcription of large speech samples precluded the use of more than two transcribers. The transcribers comprised the present researcher (referred to as transcriber 1) and a graduate speech pathologist (referred to as transcriber 2).

Since phonetic transcription forms the basis for phonological analysis, it was crucial that transcriptions of disordered speech were reliable (Shriberg, Kwiatkowski and Hoffmann, 1984). To ensure this, the following precautions were taken:

- (a) selection of an appropriate system for phonetic

- transcription,
- (b) training of transcribers,
- (c) establishing the procedure for phonetic transcription of the speech samples.

a. Selection of a system of phonetic transcription

All speech samples were transcribed using narrow phonetic transcription. As used in the present study, narrow phonetic transcription involved phonetic symbols as well as a variety of diacritics to add phonetic detail.

A system of phonetic transcription was sought which would capture the features unique to these children's speech, and which would permit the description of speech sounds not part of adult English. Specifically a consistent set of symbols was required to denote characteristics of the speech of cleft palate children such as *compensatory articulation*, *hypernasality*, *nasal emission*, *coarticulation* (involving two simultaneous places of articulation), and *silent articulations*. The widely used International Phonetic Alphabet (IPA) was considered limited as it was originally designed for the transcription of normal adult speech (Progress Report of Phonetic Representation of Disordered Speech, 1980) and as such does not account for phonetically deviant phenomena found in disordered speech. Although an accompanying system of diacritics has been proposed to broaden the range of segments possible to transcribe phonetically, the IPA remains too broad to precisely describe the speech of cleft palate children (Moller et al., 1983).

Therefore, a set of transcription symbols was compiled, which were used in conjunction with the IPA (revised to 1979). These symbols were derived from several sources, including the diacritic systems proposed by Moller et al., (1983); Shriberg and Kent (1982), the articulatory additions to cleft palate speech proposed by Trost (1981), as well as the recommended additional symbols suggested by

the working group on the *Phonetic Representation of Disordered Speech* (1980). A list of the additional symbols and the relevant diacritics are contained in Appendix D.

b. Training of transcribers

Both the researcher and the second transcriber underwent preliminary transcription training sessions. These sessions were deemed necessary to ensure that the transcribers were familiar with the transcription symbols and could anticipate and recognise the potentially subtle and complex articulation postures which might arise. Features of coarticulation, audible nasal emission and its perceptual relationship to hypernasality, pharyngeal as opposed to oral and glottal articulations, and the discrimination of fricative productions, were among the characteristics of cleft palate speech that were highlighted and matched with their phonetic transcription symbols.

For training purposes, an audiotape was constructed by the researcher which comprised 20 single words and 15 one-minute segments of connected speech from four speech disordered preschool cleft palate patients not included in the experimental group. The samples were chosen for the variety of errors of speech sound production they displayed to enable the transcribers to practise transcribing non-English speech sounds.

Training was held over two two-hour sessions separated by one week to provide a means for the assessment of stability of transcription. The same tape was played on both occasions and the transcribers were requested to transcribe the utterances making use of transcription symbols provided.

Evaluation of intra-observer agreement, i.e. stability of transcription, was calculated by means of an item-by-item reliability procedure. This offers the advantage of determining the consistency



of transcription of individual responses (McReynolds and Kearns, 1983) and therefore provides an indication of which behaviours would require retraining. *Instances of agreement and disagreement were determined for the same speech samples transcribed in the two training sessions. Agreement was defined as concurrence between the transcriptions of consonants made by the same observer from session 1 to session 2. In this regard, the concept of "functional equivalence" (Shriberg and Kent, 1982) was applied. This refers to "essentially equivalent phonetic transcriptions of a target behaviour that uses alternative symbolization" (p.448). For example, [t̥] (voiceless palatalised alveolar stop) and [c] (voiceless palatal stop) were considered functionally equivalent and hence in agreement. Instances of disagreement reflected differences in transcription.*

The formula used to calculate intra-observer agreement was derived from Shriberg and Kent (1982) and McReynolds and Kearns (1983):

$$\text{Percentage agreement} = \frac{\text{Number of agreements}}{\text{Number of agreements and disagreements}} \times 100$$

*Agreements on single word and connected speech transcriptions were calculated separately. The results indicated agreement in greater than 80% of cases, which was considered acceptable in terms of the guidelines proposed by Kazdin (1977, cited by McReynolds and Kearns, 1983, p. 156).*

#### c. Procedure for phonetic transcription

Recordings were transcribed on-site, i.e. at the time of testing and from audio recordings as soon as possible following the recording session.

##### i. On-site transcriptions

Transcriber 2 was present for the elicitation of the speech samples. Her purpose at this time was to note the presence of the visual features accompanying oral articulation which were inaudible and could not be obtained through play-back of audio recordings

(Ingram, 1976). For example, transcriber 2 was instructed to record the presence of nasal grimacing, nares constriction, tongue and lip postures for the interdental and labiodental fricatives, unreleased stops, and articulatory movements for the production of non-English sounds, particularly distortions. Precise phonetic transcriptions were not required during on-site recordings.

#### ii. Transcription of audiotaped recordings

Each transcriber transcribed the speech samples for each subject independently. An interval of no longer than one week elapsed between recording and transcription so that subtleties of the interaction would not be forgotten. In order to standardise the process of phonetic transcription, the following guidelines or conventions, drawn from the manuals of Shriberg and Kwiatkowski (1980) and Shriberg and Kent (1982), formed the basis of the transcription procedure:

- The audiotapes were replayed to ensure all utterances were glossed. Unintelligible utterances which formed less than 5% of the speech samples were discarded.
- No more than three playbacks were permitted before the utterance was transcribed. According to Compton (1975) the quality of perceptual judgements deteriorates with more frequent repetitions.
- Fine grained phonetic detail, e.g. degree of aspiration or amount of nasality was omitted from the transcription.
- Sub-phonemic features, e.g. aspiration, hypernasality, duration of vowels and consonants were only transcribed when their values differed from the anticipated phoneme. Instances in which final consonant deletion was accompanied by increased duration of the preceding vowel were noted.
- Since the primary focus was the study of consonant production, the precise transcription of vowel sounds was not considered

obligatory.

- The entire utterance was to be transcribed as both normal and abnormal speech sound productions were being examined.
- Transcribers were requested to slow down the recording so that errors in voicing could be noted as far as possible.
- Anticipation of variability and inconsistency in production of the same phoneme was emphasized.
- Where transcribers were doubtful as to the transcription of the phoneme, they were asked to transcribe their alternatives which were considered during the meeting of consensus (discussed below).

After all speech samples had been transcribed, the transcribers met to finalise a set of transcribed data which could be used for phonological analysis. This is referred to as a meeting of consensus, the procedure for which is described below.

#### 4. Procedure for consensus transcription

A procedure of consensus transcription (according to the procedure outlined by Shriberg et al., 1984) was employed in preference to the item-by-item agreement used to calculate intra-subject reliability. Unlike item-by-item agreement, consensus transcription offers a means of handling those items which differ in their transcription without having to discard them (Shriberg et al., 1984).

During the meeting of consensus, the independent transcriptions of both observers were compared for concurrence. The principle of "functional equivalence" (described on p. 92) was applied. Non-concurring items which formed 22% of the utterances were then considered for consensus. The relevant items on the audio-recordings were replayed to a maximum of three times. Each observer was required to re-transcribe the utterance. Neither transcriber was in possession of their own previous transcriptions in order that these responses would not be contaminated. If the transcription of both observers

concurrent, then the transcription of this session was included in the analysis. If disagreement was still apparent, the transcription was discussed until a compromise decision was taken. Considerations such as the subject's habitual production of the phoneme/s in question, the principle of giving the subject the "benefit of the doubt" and the principle of "functional equivalence", guided the consensus decision. Those items where it was impossible to reach consensus, in spite of these guidelines, were discarded from the analysis.

#### B. Assessment of phonemic perception

As was stated in Chapter 4, the Speech-Production-Perception (SPP) Test (Locke, 1980b) was used to assess phonemic perception. The basic theoretical assumption on which this test is based is that phonemic perception precedes phonemic production, i.e. if a child is able to produce a particular target sound, it is likely that he has adequate phonemic perception for that sound. This test directly taps the child's intrapersonal discrimination abilities as it is based on the child's discrimination of errors in his own speech (Bernthal and Bankson, 1981).

##### 1. Description of the SPP Test

No preselected stimuli were used in the administration of this test. Instead, the child's errors on the naming task formed the stimuli for the SPP Test. Therefore, each SPP Test differed for each subject. The task required the subject to discriminate his error sound from the target sound and a perceptually similar control phoneme. The control phoneme was included to ensure that the subject was making the distinction between the target sound and his error sound and not a different sound.

##### 2. Procedure for administration of the SPP Test

The naming task was administered to each subject using the procedure described above. The data from the naming task were transcribed and the speech sound production errors contained therein formed the

stimuli for the SPP Test. A response form was developed similar to that used by Locke (1980b). The following information was contained on the form:

a. The error sound, i.e. the exact error made by the child, including distortions, omissions or substitutions. These formed the stimulus phonemes (SP)

b. The target phoneme, referred to as TP

c. A perceptually similar control phoneme (CP). The control phoneme was selected from a table created from misperception data, developed by Wang and Bilger (1974). In this table each English consonant is followed by five perceptually similar sounds, e.g. the phoneme /θ/ is followed by /f, s, p, t, k/. The sound selected as the control phoneme in the SPP Test was the sound which was closest to the target sound in terms of perceptual distance, i.e. /f/ in the above example.

Alongside each stimulus item were the words "yes" or "no" to be circled depending on the subject's response (see below). For each subject, a response form was prepared prior to the administration of the SPP Test. Each error phoneme made by the subject was entered onto the form in the context of the exact word the subject had produced. For example, if the subject's production of the target word "big" was [mɪg], the target phoneme was entered on the form as /b/, the error or stimulus phoneme was [m] and the control phoneme was [v]. The target word "big" which became the stimulus type, was also entered on the form. Only one error per word was tested at one time to ensure that the subject responded to that error and not to others that might have been contained in the word. For example, if "big" was produced as [mɪ2], discrimination of /b/(TP) vs /m/(SP) vs /v/(CP) was tested first. This was followed by the same procedure in which the subject was required to distinguish /g/(TP) from /2/(SP) from /k/(CP).

Locke (1980b) recommends that each stimulus type is presented six times in order to ensure that the responses are reliable. However,

the numerous errors made by the subjects in the present study precluded more than a single presentation of each stimulus type. This is recognised as a limitation of the methodology employed for the assessment of phonemic perception in the present study, which was, as has been stated, not the major aim of this research.

The SPP Test was administered by the researcher in a separate testing session approximately four days after the administration of the naming task. The testing environment for the administration of this task was the same as that of the speech production tasks. The examiner selected the objects from the naming task which had elicited the subject's error sound production. In several cases, this included all the objects in the naming task. The instructions to the subject were as follows:

I am going to say the names of these toys. Some of the names I say may sound funny to you. I want you to listen very carefully and then you must tell me if I have said the right name. Are you ready?

The researcher held up each object which had elicited the error production and then said "Is this \_\_\_\_\_". The subject's error production, the target phoneme and the control phoneme were presented in no specified order. The subject was required to say "yes" or "no". Depending on the subject's response, either the word "yes" or "no" was circled on the response form, and this formed the basis for the analysis of the data. This procedure was continued in the same way until all of the stimulus errors were tested.

Two problems encountered in the administration of the SPP Test raised serious doubts as to the validity and reliability of the subjects' responses. With regard to validity, the question arose as to the researcher's proficiency in reproducing the non-English errors made by the subjects, such as palatal, pharyngeal and glottal substitutions and distortions for the target sound. If the test of phonemic perception is to be efficient, it must be assumed that the examiner is capable of producing sounds which closely resemble the

child's error utterances (Locke, 1980a). Although every effort was made by the examiner to practise the error sound productions prior to the testing of each subject, the possibility remained that the examiner did not perceive the subject's distortions correctly and that the examiner's production did not closely resemble that of the subject.

The second problem was that of the reliability of the subjects' responses. The high number of errors of speech production for each subject made the total number of stimulus types presented to each subject equally high, i.e. approximately 50 types. Even though phonemic perception testing was conducted in a separate session, this resulted in rapid fatigue on the part of the subjects, who lost concentration and began to respond indiscriminately to the stimuli presented. This response behaviour continued despite frequent breaks in testing and attempts on the part of the examiner to regain the subject's attention.

The combined risks of potentially unreliable and invalid data resulting from these previously unanticipated problems in the assessment of phonemic perception led the author to exclude this data from the present study. Future research should perhaps consider assessing phonemic perception over several sessions in order to ensure reliable responses. In view of the limitations of this procedure in the present study, the remainder of this report focuses only on the description of speech sound production data.

#### V. DATA ANALYSIS

The transcribed data comprised 16 speech production samples from the eight four year old cleft palate children. Eight single word samples were elicited by means of the naming task and eight connected samples which were obtained from the picture description task. Each single word sample consisted of 87 lexical types, i.e. 87 different words. (See Appendix E for naming task data for each subject). The average

number of lexical types in the connected speech samples was 260.4 words, and the average number of phonetic tokens i.e. "any attempt to produce a lexical type" (Ingram, 1981, p. 23) was 313.9. All lexical types and phonetic tokens, irrespective of their correctness, were analysed by the present researcher. For the purposes of phonological analysis and organization of the data, connected speech samples were dealt with as though they were isolated lexical items.

The primary goal of the present study was to describe the disordered speech sound production of cleft palate children using phonological process analysis. However, in order to facilitate meaningful interpretation of the results of the phonological process analysis, the data for each subject were examined for the phonetic inventories observed and the percentage of consonants correctly produced.

As will become apparent when the results of the phonological process analysis are presented in the following chapter, this analysis procedure was selective in the errors it described. Therefore, it became necessary to perform a supplementary analysis procedure: an analysis of the system of phonemic contrasts for each subject (Grunwell, 1981; 1982).

Thus, the speech production data obtained from the naming and connected speech tasks for each subject were committed to the following analysis procedures:

- A. Phonetic inventory
- B. Percentage of consonants correct
- C. Phonological process analysis
- D. Contrastive analysis

The rationale for the selection of each component of the phonological analysis battery as well as the procedures followed are described below.



#### A. Phonetic inventory

The phonetic inventory described the consonant repertoire used by each subject. It included all consonants, whether correct or incorrect, produced anywhere in both the naming task and *connected* speech samples. This measure determined which English sounds the subject was capable of producing, which English sounds were absent from his/her repertoire and which non-English sounds were used. In sum, the phonetic inventory provided an estimate of the subject's phonetic ability (Ingram, 1981; Khan and Lewis, 1984; Schwartz, 1983). Correct production of an English consonant, even if it did not match the target phoneme, was interpreted as evidence of adequate oral structure and function in relation to the production of that particular sound (Khan and Lewis, 1983; Stoel-Gammon, 1980).

In accordance with Grunwell's (1981) approach, the segments of the subjects's phonetic inventories were referred to as "phones" as no attempt had been made at this stage of the analysis procedure to determine whether the sounds constituted contrastive phonemes or allophonic variants for each subject.

*The phonetic inventories were constructed as follows:*

1. All singleton consonants produced by each subject in both the naming and connected speech samples were considered for inclusion in the phonetic inventory. Consonant clusters were excluded from the phonetic inventory as they commonly reflect speech sound production found elsewhere in the subject's sound system (Crystal, 1982). The production of consonant clusters was described fully in the phonological process analysis. In order to be included in the phonetic inventory, a consonant sound or phone had to have occurred at least three times in the sample (Grunwell, 1982; Stoel-Gammon and Dunn, 1985). Phones which occurred only once or twice in the samples were considered "marginal" and were excluded from the analysis. This precautionary measure was implemented to ensure that the phones included were indeed part of the subject's phonetic repertoire and

were not due to errors of transcription or slips of the tongue.

2. The phonetic inventories were organised in terms of place and manner of articulation (Grunwell, 1982; Ingram, 1981). This enabled the researcher to determine whether the subjects showed a preference for certain consonants and whether others were absent.

3. The position of the consonant in the syllable was not considered in determining the phonetic inventory as the purpose of this procedure was to determine the number of consonants the subject was capable of producing without reference to the target sound. Therefore, consonants occurring in syllable initial and syllable final positions were combined to form a single inventory.

#### B. Percentage of consonants correct

In order to determine the extent to which consonants were correctly produced relative to the target sound, the percentage of consonants correct (PCC) was computed for each subject according to the procedure suggested by Shriberg and Kwiatkowski (1982b). The PCC (which was originally based on connected speech samples of 4-8 year old phonologically impaired children), forms a severity rating from mild to severe "that captures the quantitative and qualitative correlates of disability, intelligibility and handicap" (Shriberg and Kwiatkowski, 1982b, p. 266).

Calculation of the PCC value for each subject involved assigning each consonant produced in the combined naming and connected speech samples to one of two categories: a "correct" category or an "incorrect" category. For this purpose, the scoring rules suggested by Shriberg and Kwiatkowski (1982b) were followed. The response definition was "score as incorrect unless heard as correct" (p. 267). Questionable responses were assigned to the incorrect category as were deletions of target sounds, substitutions, partial voicing of initial target sounds, deletions and additions.

After each segment was assigned to either the "incorrect" or "correct" category, the PCC value was calculated using the following formula.

$$PCC = \frac{\text{Number of Consonants Correct}}{\text{Number of Correct} + \text{Incorrect Consonants}} \times 100$$

(Shriberg and Kwiatkowski, 1982b).

Thereafter, the PCC value for each subject was classified according to one of four severity categories: mild = 85-100%, mild-moderate = 65-85%, moderate-severe = 50-65%, and severe = less than 50%.

### C. Phonological process analysis

The goal of this section was to determine whether the speech sound production errors of the subjects could be described in terms of phonological processes. As mentioned in previous chapters, a phonological process was defined as a systematic sound change which affects the contrasts of a class of sounds (e.g. alveolar consonants) or sound sequences (e.g. /s/ + stop clusters) (Edwards, 1982).

#### 1. Classification of phonological processes

Numerous sub-divisions have been proposed to classify phonological processes into broad categories (Edwards and Shriberg, 1983; Grunwell, 1982; Hodson, 1980; Ingram, 1976; Khan and Lewis, 1984; Stoel-Gammon and Dunn, 1985; Weiner, 1979). Although these classification systems differ in terms of their broad categories, the nature of the processes described are very similar. The framework used by Edwards and Shriberg (1983) was adopted for the phonological process analysis in the present study, as it is sufficiently broad to incorporate an open set of processes, i.e. it permits the researcher to describe unusual and idiosyncratic processes as well as those which are commonly reported in the speech of phonologically impaired and normally developing children. Within this framework, phonological processes were divided into three broad categories, the definitions of which are provided below:

a. Substitution processes

Substitution processes account for the replacement of one sound for another without reference to neighbouring sounds (Ingram, 1981; Weiner, 1979). Substitution processes are further sub-divided into those processes which affect the contrasts of

- i. manner of articulation e.g. stops replace fricatives
- ii. place of articulation e.g. velars replace alveolars
- iii. voicing e.g. devoicing of final consonants

A separate category, iv. refers to those substitution processes which merge several features in a single phoneme, e.g. glottal replacement, in which [ʔ] is substituted for obstruent consonants, and affects the features of place, manner and voicing. For convenience this category was referred to as "Other processes".

b. Syllable structure processes

Syllable structure processes simplify the syllable structure of the target word (Edwards and Shriberg, 1983). Usually the simplification lies in the direction of the early acquired CV syllable shape (Weiner, 1979), e.g. consonant clusters may be simplified from CCV to CV, and CVC words may be replaced by a CV form.

c. Assimilation processes

Assimilation processes are identified when "one sound is influenced by another, and becomes more similar or identical to it" (Edwards, 1982, p. 4). A sound occurring early in a word may affect a later occurring sound (progressive assimilation) e.g. "big" is produced as [bɪb], or a sound occurring later in a word may affect one which occurs earlier (regressive assimilation) e.g. "dog" is produced as [gɔg].

2. Procedure for coding phonological processes

The ensuing section describes the procedures for coding the sound changes as phonological processes and for determining the frequency

of occurrence of the processes. Several sources (Dunn and Davis, 1983; Edwards, 1982; Grunwell, 1982; Hodson, 1980; Ingram, 1981; Khan and Lewis, 1984; Weinur, 1979) contributed to the procedure followed for phonological process analysis.

The phonological process analysis was performed separately for each subject on data from both the naming and connected speech samples. All transcribed data for which the intended target was known were analysed. Unintelligible utterances, which comprised less than 5% of the total number of utterances, were excluded from the analysis. Each word was carefully examined in order to ascertain which phonological processes accurately described the sound changes made by the subjects. Processes were identified from an open set, in that any sound change which fulfilled the definition of a phonological process was described as a phonological process. (The issue of closed versus open sets of phonological processes is discussed in Chapter 4). Previously documented phonological processes (Edwards, 1982; Edwards and Shriberg, 1983; Grunwell, 1981; Hodson and Paden, 1981; Ingram, 1976; Weinur, 1979) reported to be common in phonologically impaired and normally developing children were used as guidelines. Definitions of the processes observed in the data are contained in Chapter 7.

Instances in which the sound change represented a distortion of the target consonant such that the phonemic contrast of that sound was not affected, were considered as phonetic errors and not as phonological processes. For example, the substitution of a voiceless pharyngeal stop [ʔ] for /k/ and not for any other consonant was considered a phonetic error. (The issue of phonetic versus phonological errors received detailed consideration in Chapter 4). All errors, including those words in which multiple errors occurred, were examined for evidence of phonological processes (Khan and Lewis, 1984). Furthermore, if a sound change could be accounted for by more than one process, both possibilities were recorded, e.g. in the case of [gɔg] for "dog", either velar assimilation or velarisation could

apply. In this instance, both processes were noted; the final decision as to which process was operating depended on the way in which the subject treated other velar consonants (Edwards, 1982).

The occurrence of each phonological process was summarised in terms of the segments or sound sequences affected. In addition, the syllable position of the segment affected by the process was noted (Ingram, 1981). This enabled the researcher to determine the extent to which the phonemic contrasts affected by the process were merged.

### 3. Procedure for determining the frequency phonological processes

The relevance of a phonological process to a child's phonological system depends on the frequency with which the process occurs (Stoei-Gammon and Dunn, 1985). In the present study, the frequency of phonological process occurrence was expressed in terms of a percentage, i.e. the number of actual occurrences of a process was divided by the number of potential occurrences, and a percentage was computed (Edwards, 1982; Hodson, 1980; Khan and Lewis, 1984). A percentage of occurrence was computed for two reasons: firstly, it controls for variations in sample size and hence unequal opportunities for process occurrence (Khan and Lewis, 1984), and secondly, it serves as a standard which facilitates inter-subject comparison.

The percentage of occurrence of all processes was computed and the results are presented in Chapter 7. In order to ensure that the sound change could accurately be described as a phonological process, it had to fulfill the qualitative and quantitative criteria for process occurrence which were outlined in Chapter 4, i.e. the process had to affect more than a single member of a sound class and had to occur in at least 20% of items in which the process could apply (McReynolds and Elbert, 1981). When the criteria for process occurrence were achieved, the process was considered productive.

Having calculated the percentage frequency of occurrence of the phonological processes in both tasks for each subject, the investigator was interested in determining whether there was a significant difference in process occurrence in the naming as opposed to the connected speech task.

4. Comparison between percentage frequency of phonological process occurrence in the naming and connected speech tasks

In view of the observation that cleft palate children display improved articulatory proficiency in single word than connected speech tasks (Morris, 1968), it was assumed that significant differences in the frequency of process occurrence would yield valuable information regarding the influence of connected speech on the articulatory skills of the cleft palate subjects. To determine whether the percentage frequency of phonological processes in the naming and connected speech tasks was significantly different, T-values for the Wilcoxon Matched Pairs Signed Rank Test (two-tailed) were computed according to the procedure suggested by Brüning and Kintz (1978). This statistic was selected as it considers both the magnitude and direction of the difference between the pairs of data (Ventry and Schiavetti, 1980). A confidence level of 95% was used to determine the presence of a significant difference between the two tasks. As all subjects did not demonstrate all phonological processes, a cut-off of 6 pairs of data (as suggested by Shearer, 1982) was applied before the statistic was computed. Tied pairs of data (i.e. where the frequency of occurrence of the process was the same on both tasks) were discarded from the test as they contained no information of change in either a positive or negative direction.

Using the procedure described above, phonological process analysis was conducted first on the naming task sample and then on the connected speech sample. The analysis procedure was held constant for each subject.

#### D. Contrastive analysis

As was mentioned above, phonological process analysis describes the strategies used by a child to simplify the adult target phoneme. By definition therefore, phonological process analysis is an error analysis. In order to obtain a comprehensive system of the subject's phonemic contrasts, i.e. those that he/she was able to signal, as well as those which were lost, an analysis of contrastive phones was undertaken. This analysis was conducted after the phonological process analysis for all subjects had been completed and the results thereof, had been examined.

The purpose of the contrastive analysis was to identify which phones produced by each subject were used contrastively to signal meaning differences and which were allophonic or non-contrastive variants of the phonological contrast in the adult system (Grunwell, 1981). Thus the adequacy of each subject's phonological system was compared with the adult system of phonemic contrasts.

Contrastive analysis was conducted according to the procedure suggested by Grunwell (1981, 1982) and Stoel-gammon and Dunn (1985). The following guidelines were used:

1. The contrastive analysis was performed separately for singleton phones used in syllabic initial and syllable final positions because of the possibility that different systems of contrastive phonemes may exist at different places in syllable structure (Grunwell, 1982).
2. Each phone was examined to determine whether or not it occurred in free variation with another potentially contrastive phone. For example, the phones [p] and [b] were considered contrastive in the following sample:

pig	[pr-]	big	[big]
pen	[pen]	bed	[bed]
pea	[pi:]	bee	[bi:]

Thus, a phone was considered contrastive when there was "no positive



evidence to suggest that it should be analysed as a non-contrastive phone" (Grunwell, 1982, p.84), i.e. every phonetically different segment (English or non-English) was regarded as potentially contrastive (Grunwell, 1981; 1982). At least three instances of contrastiveness had to be demonstrated in order to analyse a particular phone as contrastive (Stoel-Gammon and Dunn, 1985).

A phone was analysed as non-contrastive if it occurred in free variation with another potentially contrastive phone. Using the same example cited above, [p] and [b] would be considered non-contrastive variants, (i.e. indicating loss of phonological contrast) in the following sample:

pig	[pɪg]	big	[pɪg] [bɪg]
pen	[ben] [pen]	bed	[bed]
pea	[pi:] [bi:]	bee	[pi:]

All non-contrastive variants occurring three or more times were noted. Occurrences of non-English phones were examined in the same way as were English phones.

4. Having determined which phones were contrastive and which were non-contrastive, these were then compared with the adult system of phonemic contrasts in syllable initial and syllable final positions. Contrastive and non-contrastive phones were entered onto item and replica charts adapted from Grunwell (1983), Ingram (1981), and Stoel-Gammon and Dunn (1985). These charts comprised two sets of box diagrams, one for syllable initial position and the other for syllable final position. In each set, the adult system of phonemic contrasts formed the "item" and the subject's system of phonemic contrasts formed the "replica".

If the subject used one phone for two or more target phones, the symbol for the subject's contrastive phone was entered into each box. This indicated that the contrast between two or more target phonemes had been lost. Where more than one contrastive phone was used as the

regular realisation of a single target phoneme, the symbols for all realisations were entered in the appropriate box, indicating variability in phone production.

Thus, the contrastive analysis enabled the researcher to determine the adequacy and efficiency of each subject in signalling the meaning differences of adult English.

#### VI. SUMMARY

This chapter contained a detailed account of the general research design and methodology of the present study. The aims of the study were described and the major criteria for subject selection were listed. Subjects were described in terms of their clinical characteristics.

Speech production data collection included two speech elicitation tasks: a single word object naming task and a structured connected speech task. Procedures for recording and transcribing the data were detailed.

The methodology employed for the assessment of *phonemic perception* was described. However, owing to serious problems in the reliability and validity of the data collected, this aspect of the study was abandoned.

Speech production data were analysed in terms of four complementary procedures which formed the phonological analysis battery, namely phonetic inventory, percentage of consonants correctly produced, phonological process analysis and contrastive analysis.

#### CHAPTER 6

#### RESULTS AND DISCUSSION OF RESULTS-PHONOLOGICAL PROCESS ANALYSIS

The results and related discussion of the results of the phonological analyses are presented in Chapters 6 and 7. Chapter 6 contains a description of the phonological processes used by the subjects in terms of their percentage frequency of occurrence and the segments affected by the processes; Chapter 7 describes the results of the phonological analyses for individual subjects.

In the present chapter, an attempt is made to extract trends displayed by the subjects as a group. Although examples from the speech samples are used to elucidate important findings, the phonological systems of individual subjects are not discussed. Each phonological process observed in the samples is discussed with reference to literature regarding phonological process occurrence in normal and phonologically disordered children as well as to speech disorders in cleft palate children. As was mentioned in Chapter 5, the phonetic inventories and the overall percentage of consonants correct were determined as a framework for interpreting the results of the phonological process analyses. The results of these procedures are also contained in this chapter.

As will become apparent in the discussion of results below, phonological processes could only describe selected errors of speech sound production displayed by the subjects. In order to arrive at a comprehensive description of the subjects' phonological systems (including correct as well as incorrect productions), the results of the contrastive analysis, phonological process analysis and phonetic inventory are presented for each subject in Chapter 7.

The results of the phonological process analysis presented in this chapter are divided into two sub-sections. The first sub-section (1) deals with the broad findings of the phonological analyses for the

subjects as a group and is organised as follows:

- A. Group phonetic inventory
- B. Group percentage of consonants correct (PCC)
- C. Group phonological process occurrence

The second sub-section (II) provides a description of the *phonological processes used by the subjects*. In this sub-section, the phonological processes are presented in terms of the broad categories of *process occurrence*, namely substitution processes, syllable structure processes and assimilation processes.

In keeping with the descriptive nature of the study, the results in this sub-section are, in the main, presented in terms of frequency distributions displayed in histographic form. Such graphic representation has the advantage of providing an easily viewed overall summary of the characteristics and distribution of the results (Ventry and Schiavetti, 1980). Examples from the speech samples are included to elucidate findings of particular interest.

#### I. GROUP FINDINGS

##### A. Group phonetic inventory

Using data from both the naming and connected speech samples, a phonetic grid (Fig. 2) was constructed to reveal those phones comprising the total phonetic repertoire of the group. This grid was adapted from Ingram (1981) and was modified to include the frequent production of non-English phones used by the present subjects. The rows of the grid contain the place of articulation in an anterior to posterior direction, and the columns are formed by the manner of articulation classes. The number of subjects who produced the various phones are contained in parentheses in an attempt to reflect the heterogeneous nature of the subjects' phonetic abilities.

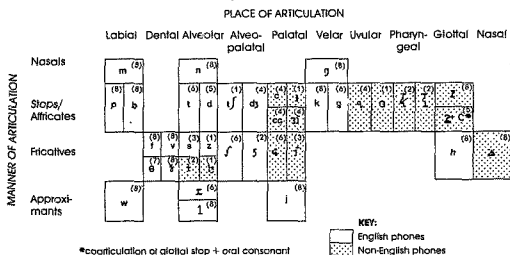


Fig. 2: Group phonetic inventory based on naming and connected speech data. (The number of subjects producing each phone is contained in parentheses)

The group phonetic inventory revealed the following most notable trends:

1. Marked heterogeneity among the subjects was observed. No subject behaved in the same way as any other.
2. No subjects gave evidence of the full range of English consonants.
3. All subjects demonstrated the use of several non-English phones. These included the frequent occurrence of glottal stops, either in isolation or coarticulated with an oral consonant, e.g. [ʔp, ʔt, ʔf, ʔʃ]; uvular and pharyngeal stops [q, ɢ, ʕ, ʁ]; palatal stops [c, ɟ]; palatal fricatives [ç, ʝ]; palatal affricates [çç, ʝʝ]; lateral fricatives [ɬ, ɮ] and nasal shorts [ɰ].
4. English sibilant phones, namely [s, z, ʃ, ʒ, tʃ, dʒ] were not produced by many subjects. English affricates were conspicuously absent.
5. With the exception of /r/ in some cases, all subjects were capable of nasal and approximant articulation.

As mentioned previously, the phonetic inventory only provided information regarding the repertoire of consonant phones present in the speech samples of all subjects. The relationship of these phones to the adult English target phoneme is not revealed by this analysis.

#### B. Group percentage of consonants correct

The percentage of consonants correct (PCC) for the group was calculated on the basis of data obtained from both the naming and connected speech tasks. The average PCC for the group was 41.75% (Table 7). The group score corresponds with the rating of "severe" on the severity rating scale developed by Sriberg and Kwiatkowski (1982b).

Table 7: Percentage of consonants correct for individual subjects and their severity ratings

SUBJECTS	TJ	CS	JM	BS	CHS	LC	SS	GH	GROUP MEAN
PCC	27	62	28	39	43	40	50	45	41.75
SEVERITY RATING <sup>a</sup>	SEVERE	MODERATE-TO-SEVERE	SEVERE	SEVERE	SEVERE	SEVERE	MODERATE-TO-SEVERE	SEVERE	SEVERE

<sup>a</sup> Severity rating is based on the scale developed by Sriberg and Kwiatkowski (1982b)

KEY:  
MILD = PCC of 85 - 100%      MODERATE-SEVERE = PCC of 50 - 65%  
MILD-MODERATE = PCC of 65 - 85%      SEVERE = PCC of < 50%

From Table 7 it is evident that the rating of "severe" for the group as a whole, generally reflects the ratings given to individual subjects in that, all but two subjects (CS and SS), obtained PCC values of less than 50%. CS and SS each received severity ratings of "moderate-to-severe" corresponding with their PCC values of 61% and 50% respectively. Sriberg and Kwiatkowski (1982b) demonstrated a high correlation between PCC values and intelligibility ratings. The obvious implication of these ratings in terms of intelligibility is that the subjects on the whole were difficult to understand.

The PCC score computed for each subject is misleading in that a sense of homogeneity among the subjects seems apparent. Although most subjects received a rating of "severe", they all performed differently in speech production tasks, as is demonstrated in

Chapter 7. Therefore, the use of the overall PCC has the potential of masking the important research findings apparent in the speech of individual subjects.

C. Group phonological process occurrence

A total of 19 phonological processes were identified in both the naming and connected speech samples. The processes observed are defined in Table 8, below.

Of the 19 phonological processes identified, eight did not fulfill both the quantitative and qualitative criteria for process occurrence, outlined in Chapter 4. These processes were stopping, gliding of fricatives, nasal replacement, velar fronting, devoicing of initial consonants, weak syllable deletion, and coalescence. In most cases, the qualitative criterion was achieved, i.e. the processes affected more than a single member of a class of sounds. However, these processes failed to achieve the quantitative criterion, i.e. they did not apply in 20% of potential occurrences of the process. It is possible that these processes were evident earlier on in the phonological development of the subjects and their low occurrence may be related to the normal development of process suppression. In view of the fact that these processes did not meet the specified criteria, they are considered marginal and were therefore excluded from further discussion. Hereafter, only the processes which could be reliably demonstrated in terms of the criteria for process occurrence are described.

Table 8: Definitions of the 19 phonological processes observed in the naming and connected speech samples across all subjects

PROCESS CLASS	PROCESS	DEFINITION	EXAMPLE Target      Response
SUBSTITUTION PROCESSES	<b>CHANGES AFFECTING MANNER OF ARTICULATION</b>		
	Liquid Simplification (LS)	Syllable initial liquids /r/ and /l/ are replaced by the glides /w/ and /j/	rabbit [wəbɪt] balloon [bəlu:n]
	a. Gliding of liquids (GL)	Syllable final liquids /r/ and /l/ are replaced by high back rounded vowels	bottle [bɒtʌ]
	b. Vocalisation (VOC)		
	Deaffrication (DEAFF)	Affricates are replaced by fricatives	chair [ʃeɪ] badge [bædʒ]
	Non-Sibilant Replacement (NON-SIB REP)	Sibilant consonants, /s, z, ʃ, ʒ, tʃ, dʒ/ are replaced by non-sibilant fricatives /f, v, θ, ð/	soup [ʊp] brush [brʌʃ]
	Stopping (ST)	Fricatives are replaced by English stops	four [fɔː] buzz [bʌd]
	Gliding of Fricatives (GF)	Fricatives are replaced by glides	vase [wæːs]
	Nasal Replacement (NAS REP)	Oral stops are replaced by nasal consonants	pig [pɪŋ] teddy [dæntɪ]
	<b>CHANGES AFFECTING PLACE OF ARTICULATION</b>		
	Labialisation (LAB)	Lingual consonants /t, d, θ, ð, s, z/ are replaced by labial fricatives /f, v, p, b/	take [pɛɪk] thin [fɛn]
SYLLABLE STRUCTURE PROCESSES	Palatalisation (PAL)	Alveolar 'alveopalatal obstruents replacing dental obstruents /c, ʒ, ʃ, ʒ, ʒj, ʒj/	down [daʊn] fish [fɪʃ] gym [dʒɪm]
	Velarisation (VEL)	Alveolar stops are replaced by velar stops	naughty [no:ɪ] dress [dres]
	Velar Fronting (VF)	Velar stops and nasals are replaced by alveolar stops and nasals	snake [sneɪk] finger [fɪndɪŋ]
	<b>CHANGES AFFECTING VOICING</b>		
	Devoicing of Final Consonants (DFC)	Word final voiced obstruents are replaced by voiceless obstruents	lizard [bɪˈzəd] eggs [egz]
	Devoicing of Initial Consonants (DIC)	Word initial voiced obstruents are replaced by voiceless obstruents	bath [pæt] chat [tæt]
	<b>OTHER CHANGES</b>		
	Glottal Replacement (GR)	Voiced and voiceless obstruents are replaced by glottal stops /ʔ/ or glottal fricatives /h/	bit [bɪt] flag [flæ] shoe [huː]
	Cluster Reduction (CR)	Deletion of one or two members of a sequence of consonants within a syllable	star [stɑː] blocks [blɒk]
	Final Consonant Deletion (FCD)	Word final singleton consonants are deleted	zip [zɪp] torch [tɔːtʃ]
ASSIMILATION PROCESSES	Weak Syllable Deletion (WSD)	Deletion of unstressed syllables in multisyllabic words	balloon [bəˈlu:n] under [ʌndə]
	Coalescence (COAL)	The features of two adjacent consonants are combined or collapsed to form a single consonant	snail [neɪl] slide [slɑɪd]
ASSIMILATION PROCESSES	Labial Assimilation (LA)	A sound becomes a labial due to the influence of another labial sound	putting [pʊtɪŋ]
	Alveopalatal Assimilation (AA)	A sound becomes an alveopalatal due to the influence of another alveopalatal sound	glasses [glɒsɪz]
	Velar Assimilation (VA)	A sound becomes a velar due to the influence of another velar sound	take [keɪk]
	Nasal Assimilation (NA)	A sound becomes a nasal due to the influence of another nasal sound	button [bʌnən]



Table 9 below contains the average percentage of occurrence of phonological processes for the group and is constructed as follows:

- The percentage of occurrence of processes is based on the combined naming and connected speech samples to incorporate all data.
- Within each process category, processes are presented in descending order, from those processes which were applied most frequently by all subjects to those processes which were applied less frequently in only a few subjects.
- The average occurrence for each process was calculated in terms of the number of subjects who gave evidence of the process and not in terms of the group as a whole. For example, the average percentage of occurrence of glottal replacement was based on the percentage frequency scores of four subjects. The number of subjects who gave evidence of each process is contained in the last column of the table. This figure serves to further illustrate the heterogeneity among the subjects' speech production error patterns.

Table 9: Average percentage of occurrence of phonological processes in naming and connected speech samples for the subjects as a group. (The last column of this table contains the number of subjects using each process)

PROCESS CLASS	PHONOLOGICAL PROCESS	PERCENTAGE OF OCCURRENCE	NUMBER OF SUBJECTS USING EACH PROCESS
SUBSTITUTION PROCESSES	CHANGES IN MANNER	45	8
	LIQUID SIMPLIFICATION	34	7
	DEAFFRICATION	28	6
	NON-SIBILANT REPLACEMENT		
	CHANGES IN PLACE	32	8
	LABIALISATION	30	7
	PALATALISATION	20	5
	VELARISATION		
	CHANGES IN VOICING	54	8
	DEVOICING OF FINAL CONSONANTS		
	OTHER CHANGES	42	6
	GLOTTAL REPLACEMENT		
SYLLABLE STRUCTURE PROCESSES	CLUSTER REDUCTION	33	8
	FINAL CONSONANT DELETION	14	6
ASSIMILATION PROCESSES	LABIAL, NASAL, AND VELAR ASSIMILATION	AVERAGE OF FIVE OCCURRENCES PER SUBJECT	8

\* Percentage of occurrence was not computed because of the unlimited opportunity for occurrence of assimilation processes

Table 9 reveals that substitution processes occurred more frequently than syllable structure or assimilation processes. In addition, the subjects showed marked heterogeneity regarding phonological process usage. The average percentage frequency of occurrence of those processes employed by all the subjects did not exceed 54% (devoicing of final consonants). The frequency of the majority of processes occurred in the 30% range. Although it is recognised that the effect of averaging serves to dilute individual differences, two broad trends emerged for the group as a whole:

1. Certain processes occurred in the speech samples of all subjects, namely, final consonant deletion, cluster reduction, assimilation, labialization, liquid simplification and devoicing of final consonants. Of these processes, liquid simplification and devoicing of final consonants occurred most frequently, on average, for all the subjects.
2. Certain processes (non-sibilant replacement, palatalisation, velarisation, deaffrication and glottal replacement) occurred in over 20% of potential occurrences in the speech of the majority, but not all, of the subjects.

Before the detailed results of the phonological process analysis are presented, it seems appropriate to report on the difference in percentage of occurrence of processes in the naming and connected speech tasks. The same processes were identified in the data from both sampling procedures. In other words, phonological processes which occurred in the naming task always occurred in the connected speech task and vice versa.

A summary of the T-values obtained from the Wilcoxon Signed Rank Matched Pairs test is contained in Appendix F. Of the processes which fulfilled the criteria for process occurrence, only one process (devoicing of final consonants) occurred significantly differently in the naming than in the connected speech task. In this case, a higher

percentage of devoicing of final consonants occurred in the naming task than in the connected speech task. Possible reasons for this difference are suggested in the detailed discussion of the process of devoicing of final consonants, later in this chapter.

The fact that no significant differences were found between process occurrence in the two tasks was unexpected, in view of the frequent clinical and research observation that articulation disordered children, as well as children with cleft palate, generally demonstrate poorer speech production in a connected speech task than in a task requiring single word responses (DuBois and Bernthal, 1978; Faircloth and Faircloth, 1970). This observation however, was based on traditional methods of articulation analysis, and not within the framework of phonological process analysis.

The lack of overall significant difference between the frequency of occurrence of phonological processes in the two elicitation tasks confirms the findings of recent studies involving phonological process analysis. Bankson and Bernthal (1982), Benjamin and Greenwood (1983) and Paden and Moss (1985) found that young children tend to use phonological processes consistently from one speech corpus to another, irrespective of the method of elicitation.

The overall absence of differences in the nature or frequency of process occurrence between the two tasks seemed to imply that data from either or both speech sampling tasks could be used as a basis for detailed discussion. With the exception of devoicing of final consonants (where a significant difference was found), the decision was taken to describe phonological processes as they occurred in the connected speech samples only. It was assumed that data from the connected speech task was more representative of the subjects' habitual speech responses than data from the naming task.

## II. DESCRIPTION OF PHONOLOGICAL PROCESSES

The primary focus of this section concerns the description of the phonological processes identified in the data. The processes are organised according to the categories of substitution, syllable structure and assimilation processes. Examples from the speech samples are included to illustrate the application of the processes observed. The examples are drawn from the data of all subjects and are not limited to those of one particular subject.

### A. Substitution processes

#### 1. Phonological processes affecting manner of articulation

Three processes affecting manner of articulation fulfilled the criteria for process occurrence. These were liquid simplification (LS) - which comprises gliding of liquids and vocalisation, deaffrication (DEAFFRIC) and non-sibilant replacement (NON-SIB REP). The average percentage of occurrence of phonological processes affecting manner of articulation, among the subjects who used them is contained in Fig. 3.

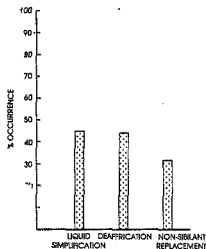


Fig. 3: Average percentage of occurrence of phonological processes affecting manner of articulation in connected speech samples

The average percentages of occurrence of liquid simplification, deaffrication and non-sibilant replacement were 45%, 34% and 31% respectively. The inter-subject application of these processes is described in detail in the following section.

#### a. Liquid simplification (LS)

Two processes (gliding of liquids and vowelization) are subsumed under the broad heading of liquid simplification, gliding of liquids and vocalisation. The percentage of occurrence of these two processes for each subject is contained in Fig. 4.

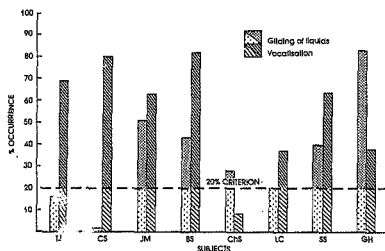


Fig. 4: Percentage of occurrence of gliding of liquids and vocalisation for each subject

#### i. Gliding of liquids (GL)

As can be noted in Fig. 4, gliding of liquids was observed in the speech of all subjects in the range 2 - 83%. Gliding of liquids was productive, i.e. its occurrence exceeded 20% for six subjects. The remaining subjects gave evidence of gliding of liquids in less than 20% of potential occurrences. In line with the findings of several researchers (Dunn and Davis, 1983; Dyson and Paden, 1983; Hodson and Paden, 1981; MacMahon, Hodson and Allen, 1983; Weiner, 1979), simplification of /r/ was more common than that of /l/. Whereas /r/ was glided by all of the subjects at

least part of the time, only JM gave strong evidence of gliding of /l/. Furthermore, since South African English is an "r-less" dialect, gliding of /r/ occurred only in syllable initial position.

Gliding affected singleton consonants as well as consonant clusters. It is possible that clusters were more frequently affected than singletons, because of their increased opportunity to occur in the speech samples and because they present the speaker with greater articulatory complexity.

Two broad patterns of application of this process emerged. In the first pattern, there was consistent use of a single glide, primarily *sch* was substituted for /r/ irrespective of whether the target sound was a singleton or a cluster. For example,

ramp	[wɑ̃p]	scrubbing	[ʒwɑ̃bɪn]
red	[weɪ]	three	[fwi:]
squirrel	[hʷɑ̃kwɔ]	truck	[tʷʌk]

This pattern was observed in six subjects.

The second pattern involved irregular gliding of liquids. In one subject, GH, the choice of glide substitution differed depending on whether the target word contained /r/ as a singleton or as a member of a consonant cluster. Where the liquid occurred as a singleton or was preceded by an alveolar or velar stop, /j/ was substituted. However, in labial clusters, e.g. /br/, /pr/, /fr/, /θr/ and /spr/, the resulting glide /w/ was conditioned by the preceding labial consonant, perhaps indicative of labial assimilation. For example,

rabbits	[jɛbɪtɪz]	brush	[bʷʌʃ]
rough	[ɹʌf]	spraying	[spwɛɪjɪn]
aeroplane	[əjɛplɛɪn]		

BS replaced /r/ with /w/, /j/ and /l/, but in a non-uniform

fashion. In this case, establishment of the conditioning factor was ambiguous. For example,

rattle	[wɛk <sup>h</sup> ɪ]	broom	[bju:m]
rouge	[lu:ʒ]	brush	[plʌʒ]
aeroplane	[ɛwɒplə <sup>h</sup> ɪ]	crying	[kwaɪjɪn]
porridge	[pɒʒɪt]	straw	[sklɔ]

The finding of a high percentage of gliding of liquids was not unexpected. According to Locke (1983), the simplification of liquids by gliding is a commonly occurring and persistent process in the speech of normally developing and phonologically impaired children. It has been suggested that the majority of normally developing four year old children have acquired correct liquid articulation, but that liquid deviations may persist in immature speakers after age 4. (Shriberg and Kwiatkowski, 1980; Grunwell, 1982). Since all but two subjects (GH and SS) were capable of correct /r/ production (see results of group phonetic inventory, p. 112) of the subjects (GH and SS), it seems reasonable to suggest that gliding of liquids was in the process of being suppressed.

#### ii. Vocalisation (VOC)

As Fig. 4 illustrates, vocalisation was widely attested by seven of the eight subjects, varying in frequency from 37% to 82% of potential occurrences. Five of these subjects employed vocalisation in more than 64% of final /l/, and only one of the eight subjects (CHS) employed this process 8% of the time.

Vocalisation occurred in singletons as well as syllable final /l/ + obstruent clusters. For example,

purple	[pɜ:p <sup>h</sup> ɪ]	candles	[kændəb]
bicycle	[baɪk <sup>h</sup> ɪ]	herself	[hɜ:ɛ <sup>h</sup> f]
castle	[kɒs <sup>h</sup> l]	milk	[mɪ <sup>h</sup> k]

The presence of vocalisation was reported in the single cleft palate subject studied by Hodson, Chin, Redmond and Simpson

(1983). Their subject demonstrated consistent use of this process, in all possible occurrences. Vocalisation has been described as characteristic of the late stages of phonological development (Ingram, 1976; Grunwell, 1982). Two-thirds of Hodson and Paden's (1981) 60 normal and all of their 60 unintelligible subjects vocalized post-vocalic /l/.

The validity of attributing this sound change to an error of manner of production is questionable in the context of the dialect of South African English. According to Lanham (1967)

a hallmark of SAE (South African English), evident in even the more conservative forms, is the attraction of short, simple vowel allophones to an original high-back component of a post nucleus, dark /l/ standing in the same syllable (p. 64).

Thus, while vocalisation of syllable final /l/ was widely attested in this population, it cannot be regarded as a true simplification of the adult target.

In summary, liquid simplification accounted for the majority of errors observed in the production of /r/ and /l/ segments. Other investigators (Phillips and Harrison, 1969; Van Demark, 1969; Van Demark et al. 1979) too have found that their cleft palate subjects misarticulated liquids more frequently than did normal speakers. The question arises as to why cleft palate speakers would have difficulty with /r/ and /l/ production. Physiological factors such as poor intra-oral breath pressure do not explain the fact that the subjects showed errors of liquid production since precise velopharyngeal closure and controlled oral air flow is not required for the accurate articulation of approximant sounds, i.e. glides and liquids (Counihan, 1979; Horrigan, 1982). Misarticulation of liquid consonants and the presence of phonological processes to account for these errors may be attributed to the effects of maturation in that liquids are acquired relatively later in the acquisition schedule (Edwards and Shriberg, 1983, p. 143).



## b. Deaffrication (DEAFF)

Fig. 5 illustrates the percentage of occurrence of deaffrication for each subject in the connected speech samples.

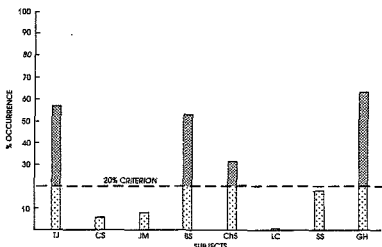


Fig. 5: Percentage of occurrence of deaffrication for each subject

As is indicated in the above histogram, the range of occurrence of deaffrication varied from 6% to 63%. While deaffrication occurred in seven of the eight subjects, it fulfilled the 20% criterion in only four subjects (TJ, BS, ChS and GH). The remaining three subjects employed this process in less than 20% of potential occurrences. In all cases, simplification of both /tʃ/ and /dʒ/ was apparent, thus meeting the qualitative criterion for process occurrence.

On occasion, deaffrication was a constituent process interacting with non-sibilant replacement or palatalisation. Deaffrication occurred predominantly in syllable final position and no clear predilection for voiced or voiceless consonants was evident. For example,

such	[ʃʌç]	picture	[pɪkʃʌ] [pɪkθʌ]
witch	[wɪh]	touching	[tʌtʃɪŋ]
cage	[kæɪç]		

As the group phonetic inventory (Fig. 2) indicates, alveopalatal affricates were present in only four subjects, with /dʒ/ occurring in more subjects than /tʃ/. Thus the appearance of this simplification process was not unexpected. The factors which possibly contributed to the occurrence of this process are the complexity of the articulation required, i.e. affricates require the delayed release of a homorganic stop and fricative (Shriberg and Kent, 1982) and the fact that high intra-oral pressure is necessary for accurate production of these consonants.

Although deaffrication is frequently listed as a process occurring in normal phonological development, its application or frequency of occurrence has not been detailed. Therefore, comparison of this process with previous research is limited. Possible reasons for the paucity of description of this process are firstly, the fact that deaffrication is evident only in the later stages of phonological development in the normal child (Ingram, 1978). Affricates are predominantly replaced by stops in the early stages of phonological acquisition (Ingram, 1978), and may only undergo the process of deaffrication in the later stages. Secondly, the process of deaffrication can be classified as a narrow process as it affects the contrast of only one cognate pair of phonemes (Weiner, 1979). The occurrence of deaffrication alone would therefore not contribute to a reduction in unintelligibility and would alone not be considered as evidence for the presence of a phonological disorder.

c. Non-Sibilant Replacement (NON-SIB REL)

This process was classified primarily as an error of manner of production as it seemed that the distinctive feature of [±sibilance], rather than place of articulation was responsible for this sound change.

Although all subjects gave evidence of non-sibilant replacement, only three subjects (Tw, US, and SS) met the qualitative and quantitative

criteria for process occurrence. The percentage of occurrence of non-sibilant replacement as it occurred in these three subjects ranged from 25 - 62% and is graphically depicted in Fig. 6.

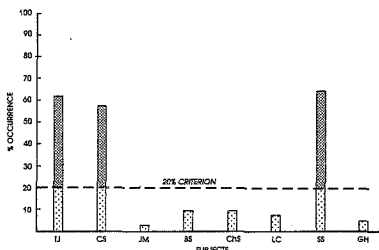


Fig. 6: Percentage of occurrence of non-sibilant replacement for each subject

As applied by the present subjects, non-sibilant replacement involved the substitution of the /θ/ and /x/ for sibilant consonants. Sibilant fricatives were more frequently affected than the affricates. Sibilants in both syllable initial and syllable final positions were equally involved, although affricates were primarily affected in syllable final position. No obvious difference was observed in the degree to which voiced and voiceless sibilants were affected. For example,

basket	[ʔbd:θəʔ]	shower	[θäʋwʌ]
aliceband	[äɪəθbän]	pushing	[pʋθin]
squeezing	[θɔwi:θiq]	rouge	[wu:ʒ]
colours	[ʌləθ]	watch	[wb:θ]
lizard	[bläðæt]	torch	[tɔ:θ]
zebra	[ʒebʌ]	bridge	[xi:θ]

Non-sibilant replacement, as used in the present study, has not been

reported in the literature on phonologically impaired or normally developing children. Hodson (1980) makes reference to the process of stridency deletion, which involves the deletion of strident consonants or the replacement of non-strident consonants for stridents /f, v, s, z, ʃ, ʒ, tʃ and dʒ/. This process differs from that of non-sibilant replacement in that the spectrum of sounds potentially affected by non-sibilant replacement is narrower than that for stridency deletion. With the exception of /θ, ð, and h/ all fricatives and affricates are potentially affected by stridency deletion. In contrast, only alveolar and alveopalatal fricatives and affricates are affected by non-sibilant replacement. Furthermore, stridency deletion may involve the replacement of any class of non-strident consonant for the strident consonant. In terms of non-sibilant replacement however, the replacement of non-sibilant fricatives are included. Hodson and Paden (1981; 1983) have observed that phonologically disordered children commonly display errors of strident consonant production, and that such errors contribute considerably to an overall reduction in intelligibility.

Although non-sibilant replacement has not been referred to in the cleft palate population in these terms, several authors have made reference to errors involving sibilant consonants (Bzoch, 1965; Fletcher, 1978; Van Demark et al., 1979). Fletcher (1978) applied the statistical procedure of principal components analysis to examine the articulatory data obtained from his 70 cleft palate subjects. The primary factor which emerged contrasted sibilant from non-sibilant sounds. He found that errors on sibilant sounds were more common and consistent than those on non-sibilant sounds. In view of his findings, Fletcher suggested that instead of grouping all fricatives in a single class, "a more homogeneous categorisation might be achieved by grouping the affricatives /tʃ/ and /dʒ/ with the other sibilants /s/, /z/ and /ʃ/" (p. 65). Non-sibilant fricatives would form a separate category of sounds. He recommended that this sub-

classification of sibilants is particularly useful for cleft palate subjects who frequently demonstrate errors of sibilant production.

In explaining his findings, Fletcher (1978) argued that sibilants are physiologically more complex than non-sibilant sounds. Precise positioning of the articulators is necessary to produce the frictional noise and high energy required for sibilant articulation.

Furthermore, sibilants require the formation of a medial groove anteriorly between the blade of the tongue and the alveolar ridge. The dimensions of this groove must be carefully controlled in order to achieve the identifying high frequency quality of sibilant sounds (Fletcher, 1978, p. 64-67). Because of the precision involved in sibilant production, Fletcher claimed that

It is then not surprising that the physiologically complex sibilants are frequently defective, especially in instances where the fine tuning of oral coordination may be impaired by subtle disturbances in oral and pharyngeal structure and function (p. 67).

## 2. Phonological processes affecting place of articulation

Three phonological processes (labialisation, palatalisation and velarisation) affecting the contrasts of place of articulation were observed in the connected speech samples. These processes can be divided into those which result in the replacement of a posteriorly articulated consonant by a consonant produced anteriorly (fronting), and those which result in the replacement of an anteriorly articulated consonant by a posteriorly produced consonant (backing). Using this division, the fronting process observed was labialisation and the backing processes were palatalisation and velarisation. The average percentage of occurrence of these processes is depicted in Fig. 7.

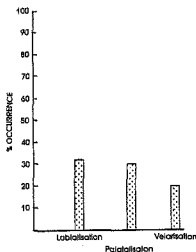


Fig. 7: Average percentage of occurrence of processes affecting place of articulation for all subjects in the connected speech samples

It must be stated at the outset, that the number of subjects who achieved the quantitative and qualitative criteria for the processes illustrated in Fig. 7 varied. For example, seven subjects employed palatalisation, and all subjects used labialisation. Although the quantitative criterion was not entirely met for velarisation by the group as a whole, it was included because it occurred frequently (63% of potential occurrences) in one subject (BS).

a. Labialisation (LAB)

As is illustrated in Fig. 8 below, all subjects gave evidence of labialisation, but varied in terms of strength of occurrence between 6% and 77%. Five subjects (TJ, CS, ChS, SS and GH) employed this process in over 20% of possible occurrences, while its occurrence was diminished in the remaining three subjects.

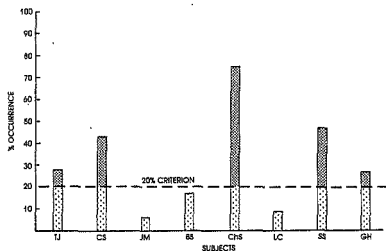


Fig. 8: Percentage of occurrence of labialisation for each subject

The consonants affected by labialisation were the interdentalals /θ/ and /ð/ which were replaced by /f/ and /v/ respectively. The distribution of the process was consistent through syllable initial and syllable final positions, as the following examples illustrate:

Syllable initial position	Syllable final position
thin [tʰən]	birthday [2b3f2(d)əɪ]
something [sʰmθfɪn]	mouth [mʌvθ]
their [vɛ:]	with [waf]
that [væ2]	smooth [çmʊ:f] [çmʊv]

The presence of labialisation in the samples of the subjects was anticipated. According to Ingram (1975) and Grunwell (1982), /θ/ and /ð/ are the most difficult fricatives for normal and deviant children to produce and are the last to be acquired. Mastery of these consonants is reported to occur between 4.6 to 5.0 years (Grunwell, 1981, Prather, Hedrick and Kern, 1975). In the present study, the average percentage of correct production for /θ/ and /ð/ were 25% and 30% respectively, which may provide evidence that for at least some subjects, the process of labialisation is undergoing gradual

suppression.

Labialisation is rarely discussed in the literature of phonologically disordered children. Ingram (1981) coined the term labialisation, but did not expand on its occurrence or prevalence in normally developing or phonologically disordered children. This may be accounted for by the fact that substitutions whereby /θ/-> /f/ and /ð/-> /v/ are usually regarded as simple developmental substitution errors and not regarded as evidence for the operation of a phonological process. It is also possible that labialisation is not frequently discussed because its effect on intelligibility is minimal if occurring in isolation. Labialisation can be regarded as a narrow process in that the contrast of a single pair of sounds is merged. This is in contrast to a broad process, for example stopping, in which several fricatives may be replaced by stops.

The presence of the process of labialisation cannot be directly related to the effects of oral structural or functional impairment, as /θ/ and /ð/ formed part of each subject's phonetic inventory as was shown in Fig. 2. Thus it is likely that the presence of labialisation falls within the normal developmental schedule and is neither deviant nor delayed.

#### b. Palatalisation (PAL)

Although palatalisation was attested in the speech of seven of the eight subjects in the range 4 - 80% of possible occurrences (Fig. 9), it was productive in only three subjects (BS, CHS, GH).



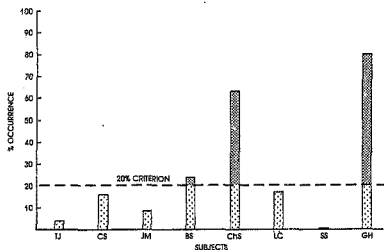


Fig. 9: Percentage of occurrence of palatalisation for each subject

As the above histogram indicates, the range of percentage of occurrence of palatalisation in the three subjects who fulfilled the criteria varied between 24% and 80%. The remaining five subjects employed this process in the range 4 - 17%.

The application of palatalisation compromises the contrasts concerning place of articulation of alveolar stops and fricatives as well as alveopalatal fricatives and affricates. Alveolar and alveopalatal fricatives were most frequently affected followed by affricates and then stops. The following examples have been selected to illustrate the application of this process.

Stops:	down	[cāṽn]	table	[čāibəl]
	slide	[č̌iāic]	hat	[hāc]
	drinking	[ʃ̌iŋǩiŋ]	eating	[i:cɪŋ]
Fricatives:	horsie	[hōč̌i]	vase	[ba:č]
	blocks	[ɪlɒǩ]	zip	[jəp̌]
	sore	[çō:]	busy	[bəji]
	shower	[çāw̃wə]	rouge	[ju:j]
	fish	[fiç]	television	[ǩɛlaviʃən]

Affricates:	chair	[tʃe]	gym	[ʒɪm]
	torch	[tɔʃ]	badge	[bædʒ]

The above examples elucidate group trends; they do not provide information about the way in which the process of palatalisation disturbed the organisation of the productive phonological system of each subject. In some cases, attributing a phonological process to this sound change was erroneous in that the production of a palatal consonant formed a simple substitution of the target sound, i.e. only a single pair of sounds was affected by palatalisation. To this extent the process of palatalisation is controversial.

As employed by the subjects of the present study, palatalisation could be described both in terms of phonetic and phonological sound change. For example, CS seemed to employ palatalisation as a phonetic distortion. He distinguished the phonemic contrast between /s/ and /ʃ/ as follows - while /ʃ/ was produced as a voiceless palatal fricative, /s/ was kept distinct by producing it as an interdental /θ/. Further evidence for this sound change being attributable to a phonetic distortion stems from the palatalisation of stops and affricates. In some cases, alveolar stops and alveopalatal affricates did not form part of the subject's phonetic repertoire; palatal consonants were used instead. In these cases, the sound change could be regarded as a phonetic distortion rather than a phonological process as the meaningful contrast between two or more phonemes was not merged. In contrast GH collapsed the alveolar and alveopalatal contrasts to a palatal consonant over all sound classes. This had the effect of reducing intelligibility because of the increased number of homonymous types. The point to be made by this discussion is that although it is possibly to attribute certain sound changes to the process of palatalisation, the distinction of phonetic versus phonological errors of palatalisation is crucial to remediation planning. For example, in the case of "phonological palatalisation", it may be appropriate to employ remediation procedures to teach

meaningful contrasts (Weiner, 1981) between the target phonemes. However in cases of "phonetic palatalisation", the application of such an approach would be spurious, because the child would have demonstrated his knowledge of the correct phonemic contrast. In this instance, traditional approaches to articulation therapy would seem apt.

Therefore, palatalisation has both phonetic and phonological manifestations. In order to determine the extent to which either of these factors were operating, detailed inspection of the systems of phonemic contrasts for individual subjects was conducted. The results of these findings are discussed in Chapter 7.

### c. Velarisation (VEL)

As was mentioned at the beginning of this section, velarisation was productive in only one subject (BS) who employed it in 63% of potential occurrences. While four subjects gave some evidence of velarisation, the percentage of occurrence did not meet the prescribed criteria (Fig. 10). The following discussion is therefore limited to the manifestation of velarisation in one subject only, viz. BS.

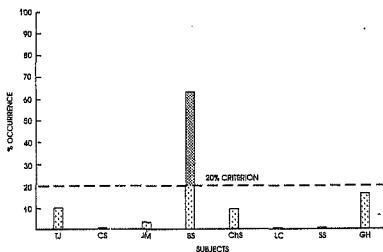


Fig. 10 : Percentage of occurrence of velarisation for each subject

Velarisation affected the voiced and voiceless alveolar stops in both syllable initial and syllable final positions, whether the target sound occurred as a singleton or in a cluster. Although the predominant substitutions for alveolar stops were velar stops, there were instances where post-velar stops (e.g. uvular or pharyngeal stops) were evident. The presence of uvular or pharyngeal stops was also considered as evidence of velarisation because of the replacement of a posterior for an anterior place of articulation. The following examples illustrate the abovementioned broad trends:

Syllable initial position

Syllable final position

tell	[kæʋ]	door	[go]	hurt	[3:k]	bed	[beq]
torch	[qɔg]	holding	[hæʋgɪŋ]	just	[gæk]	cloud	[klæʋg]
naughty	[nɔ:kɪ]	stove	[ækʋəf]	carrots	[kæwəkʃ]	tired	[ka.jæk]

It could be argued that the process of velar assimilation as opposed to velarisation was the operative process in some of the above instances, e.g. in productions of the words "tired" [ka.jæk], "holding" [hæʋgɪŋ], and "carrots" [kæwəkʃ]. However, close inspection of the speech samples revealed that the process of velarisation occurred more frequently than velar assimilation and was thus inferred as the operative process.

Hodson and Paden (1983) have distinguished the process of backing from that of velarisation. In their terms, backing refers to the replacement of alveolar consonants by velar sounds, i.e. the phonemic contrast between the two places of articulation are merged. They use velarisation to refer to the retraction of the tongue during velar consonant production. In such cases, the resultant segment is regarded as an allophonic variant of the target phoneme and not an entirely different phoneme, which would result from backing. BS demonstrated both sound changes in her speech samples. A few examples of "velarisation" in accordance with Hodson's (1980) definition are listed below:

cowboy [qæʋpɔɪ]

girls [qɔ:ɹ]

broken [b<sup>h</sup>ɔ̃q]piggie [p<sup>h</sup>igɪ]

black [2lɛq]

jug [dʒq]

It is doubtful whether the case of "velarisation" as defined above can justifiably be regarded as a phonological process, since no alteration in meaning is involved. Instead it may be regarded as a distortion of the target phoneme, where distortion refers to the closest approximation the patient is capable of, in the presence of impaired oral structure and functioning (Locke, 1983b).

Even though velarisation has been reported to occur in normal phonological acquisition (Ingram, 1974), it has been infrequently described. Grunwell (1981) observed velarisation in only one of her phonologically impaired subjects. Hodson (1980) reported that backing (which is equivalent to velarisation as used in the present study) is a "rather infrequently occurring process which devastates intelligibility when it occurs, perhaps partially because it is less expected than its contrasting process, fronting" (p. 13).

Velarisation has been referred to as the reverse of velar fronting. Grunwell (1981) and Hodson and Paden (1983) note that the two processes are mutually exclusive. This observation is aptly illustrated in BS. Velarisation was a dominant process (63% occurrence) and velar fronting seldom occurred, i.e. in only 9% of opportunities, and was thus not considered productive.

The increased occurrence of the backing processes (palatalisation and velarisation) as opposed to fronting processes, was not unexpected in the speech samples of the present subjects. This finding is supported by literature concerning tongue posture in children with cleft palate as was discussed in Chapter Two (p. 20). Abnormal tongue carriage has been implicated in disordered articulation in cleft palate speakers particularly where velopharyngeal incompetence is evident (Shelton, Brooks, and Youngstrom, 1963; Lawrence and Phillips, 1975). Retracted tongue position and tongue-dorsum

articulation have been suggested as compensatory postures adopted to reduce the presence of hypernasality (Trost, 1981). Using telefluoroscopy, Lawrence and Philips (1975) studied tongue contacts in cleft palate subjects who were judged to have adequate, borderline or inadequate velopharyngeal function. Their findings indicated that subjects with borderline or inadequate velopharyngeal status, demonstrated a considerably higher incidence of deviant lingual contacts than those who had adequate velopharyngeal function. Furthermore, deviant tongue contacts resulted in the production of posteriorly as opposed to anteriorly articulated consonants. In view of the results of the study by Lawrence and Philips (1975), it is surprising that velarisation was productive in only one subject. However, in the present subjects, support for the tendency for posterior articulatory substitutions in place of anterior targets is derived from the presence of palatalisation and glottal replacement in many of the subjects, both of which may be regarded as backing processes (Hodson, 1980).

### 3. Phonological processes affecting voicing

Only one process which affected voicing fulfilled the criteria for process occurrence, namely devoicing of final consonants. Since the frequency of occurrence of devoicing of final consonants was found to be significantly different in both elicitation tasks, the average percentages of occurrence for both the naming and connected speech samples are discussed.

Devoicing of final consonants was a frequently occurring process relative to the other processes that were identified. Its average occurrence was 61% in the naming task and 55% in the connected speech sample task. The percentages of occurrence of devoicing of final consonants for individual subjects in both the naming and connected speech samples are contained in Fig. 11.

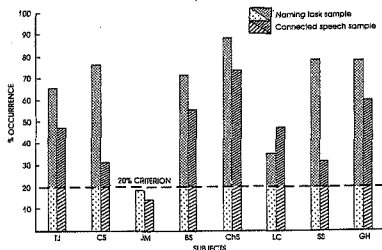


Fig. 11: Percentage of occurrence of devoicing of final consonants in naming and connected speech samples for each subject

From Fig. 11, it is evident that all subjects exhibited devoicing of final consonants in the range 18%-88% in the naming task, and 13%-73% in the connected speech sample. JM was the only subject who gave evidence of DFC in less than 20% of possible occurrences. Occurrence in the remaining subjects exceeded 35% on the naming task and 31% on the connected speech sample task.

Devoicing of final consonants occurred significantly more frequently in the naming than in the connected speech sample tasks. Several researchers (Ingram, 1976; Stoel-Gammon and Dunn, 1985; Weiner, 1979) regard devoicing of final consonants as an assimilation process rather than a substitution process. According to their definition, final voiced consonants assimilate to the following silence or pause. If this is the case, it is possible to relate the increased occurrence of devoicing of final consonants in the naming task to the fact that "silence" occurred more frequently in the single word naming task, than in the connected speech sample task involving connected speech.

DFC occurred in both singleton consonants and consonant clusters. Word-final fricatives were affected by DFC more often than either voiced stops or affricates. Of all word final voiced obstruents, /z/ was the phoneme which most frequently underwent the process of DFC. For example,

Fricatives:	nose [nɒθ]	stove [stəʊv:f]
	eggs [ekz]	rouge [nu:θ]
	smooth [smu:f]	
Stops:	web [wep]	pig [2ik]
	lizard [blɒðət]	
Affricates:	bridge [bwɪtʃ] [bwɪtθ]	
	badge [bæ:cc]	

Devoicing of final consonants has been described as a commonly occurring process in the speech of normally developing children (Hodson and Paden, 1983; Ingram, 1976; Locke, 1983b) as well as in the speech of phonologically impaired children (Hodson and Paden, 1981). Its persistence has been noted in some children until after age three (Grunwell, 1982). Furthermore, there is tendency for voiced obstruents to be only partially voiced in normal adults; the result of coarticulation effects (Stoel-Gammon and Dunn, 1985).

Positive identification of devoicing of final consonants makes assumptions about the subject's underlying phonological knowledge of voicing contrasts. In the traditional phonetic analysis, prevalence of this process would be attributed to the absence of awareness of the voicing distinction in word final position. Recent research however, has cautioned against making such assumptions as some misarticulating children may use compensatory strategies to signal the voicing contrast. For example, Hodson and Paden (1981) noted that occasionally the vowel preceding the target voiced obstruent was lengthened, despite the fact that the phonetic manifestation of the consonant was voiceless. In addition, Weismer, Dinnsen and Elbert (1981) showed that some children who appeared to neutralise the



voicing contrast of word final stops actually produced distinctive acoustic features for voiced and voiceless stops. These features were evident on spectrographic analysis and were generally imperceptible even to the trained listener.

Shriberg and Kent (1982) have suggested that the presence of vowel lengthening is a reliable cue to the voicing contrast, and its presence was therefore investigated in the speech samples in the present study. The results indicated that 75% of the occurrences of devoicing of final consonants were accompanied by vowel lengthening, suggesting that more often than not the subjects were aware of the required voicing distinction. It is possible that this contrast would have been positively identified in all the examples of DFC had acoustic analyses with reference to voice onset time been conducted.

The fact that devoicing of final consonants was relatively frequent in the speech of these subjects was in part, an unexpected finding. This is in view of the observation made by researchers such as Bzoch (1965) and Spriestersbach, Darley and Rouse (1956) that cleft palate speakers are more proficient in the production of voiced than voiceless obstruents. The relative absence of voiceless consonants would have been more predictable than their overriding presence. Close inspection of the data revealed that fricatives were more frequently devoiced in word final position than either stops or affricates. This finding is supported by later research by Spriestersbach, Moll and Morris (1961) which indicated that while voiced stops were more frequently correct than voiceless stops, the opposite trend was true for fricatives.

#### 4. Other processes

Although the category of "other processes" was introduced to account for processes which merged place, manner and voicing features simultaneously, only one process comprised this category, i.e. glottal replacement. The average percentage frequency of occurrence

of glottal replacement across all subjects was 42%. Fig. 12, below contains the frequency of occurrence of glottal replacement for individual subjects.

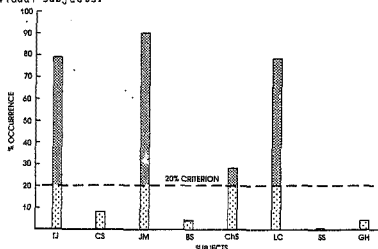


Fig. 12: Percentage of occurrence of glottal replacement for each subject

As Fig. 12 indicates, seven of the eight subjects employed glottal replacement in the range 4% - 90%. Of these subjects, three (TJ, JM and LC) gave strong evidence of glottal replacement in that its frequency of occurrence was 79%, 90% and 78%, respectively. CHS used glottal processes in 28% of opportunities and the remaining four subjects used them marginally, in under 20% of opportunities.

As defined in the present study, glottal replacement refers to the replacement of a glottal consonant, either a stop [ʔ] or a fricative [h] for oral obstruent. In six of the seven subjects who showed glottal replacement, the error sound was [ʔ]. In contrast JM, the seventh subject replaced obstruents with the voiceless fricative /h/.

Close inspection of the data revealed that glottal replacement affected the three obstruent classes stops, fricatives and affricates. Stops were most frequently affected followed by affricates and fricatives. This finding is supported by the work of Sherman et al. (1959) who noted that while glottal stops occurred predominantly as substitutions for stop consonants, other obstruents

were also affected. Glottal replacement occurred more frequently in syllable initial than in syllable final position for all target sound classes, and twice as many voiceless obstruents were affected by glottal replacement than were voiced obstruents. This trend was observed for stops, fricatives and affricates. The following examples illustrate the application of glottal replacement in subjects who substituted [ʔ] for obstruents,

bit [bæʔ]	toothbrush [hu:bɹʔ]
witch [wɪʔ]	flag [ʔlæʔ]
snake [ʔnæʔ]	

Subject JM used glottal replacement differently. He replaced all obstruents with /h/ in syllable initial position, and in syllable final position, only fricatives and affricates were replaced by /h/. For example,

flower [hāʊwə]	dress [hweh]
shoe [hū:]	fish [fih]
chair [hē]	witch [wiʔh]
torch [hō:]	badge [bæh]

In cases where /ʔ/ was the replacement phoneme, glottal replacement was accompanied by the coarticulation of an oral consonant. To illustrate, "bird" was produced as [ʔmɜ:ʔ]. The occurrence of this pattern of glottal replacement for /b/, co-occurred with the replacement of a glottal stop produced as a single articulatory event. It was noticed that the coarticulation of glottal and oral consonants was unlikely if glottal replacement was not used.

Three subjects (TJ, LC and CHS) demonstrated glottal coarticulation. Of these, LC displayed this pattern as frequently as glottal replacement. Glottal coarticulation was confined to syllable initial position in singletons as well as in consonant clusters. As was the trend for glottal replacement, target voiceless obstruents were more frequently affected by glottal coarticulation than voiced obstruents.

Of all obstruents, target stop consonants seemed particularly vulnerable to glottal coarticulation. In most cases the oral sound which accompanied the glottal stop was not the target obstruent. Instead, either a nasal consonant or another consonant already established in the subject's phonetic repertoire was reflected in the application of this process. For example,

bicycle	[2maʔI2]	door	[ɪnõ:]
fish	[ʔfIh]	gym	[2nãm]
feather	[ʔEʔda]		

The occurrence of glottal coarticulation is misleading if taken at face value. Even though its occurrence resulted in a more complex sequence of two "consonants", the overall effect was to simplify the production of what was possibly perceived by these subjects as *complex articulation*.

On the basis of clinical observations, Trost (1981) has reported the presence of the coarticulation of glottal and oral consonants in children with cleft palate. Bzoch (1979) has also noticed this phenomenon which he postulated is the result of maturation as well as an artefact of articulation therapy. In his view, the cleft palate child is aware of an oral articulation, but because of the habituated glottal stop patterns of articulation, will produce both oral and glottal consonants simultaneously.

Few reports in the literature are available with respect to the occurrence of glottal coarticulation in phonologically impaired or normally developing children. Grunwell (1981) described one subject who used, what she referred to as glottal insertion, for all types of inter-word but syllable final adult consonants and consonant clusters, with the exception of /w r l f v ʒ/. The glottal stop in this child "...was the terminating consonant of a stressed syllable ..." and served to "...reinforce the salience of the syllable" (p. 122). As a means of comparison, the application of glottal

coarticulation by LC in the present study will be considered. It is postulated that LC used glottal coarticulation as a means of combining the distinctive phonemic features into a single articulatory or coarticulatory event in syllable initial position. In other words, Grunwell's subject appeared to use glottal insertion as a strategy for the simplification of the syllable structure of the word, while LC seemed to use it as a strategy for tackling a "complex" articulation.

As was discussed in Chapter 2, glottal stops are a classical feature of the speech of children with cleft palate and occur predominantly between the ages of 3 and 4 years (Bzoch, 1979). In addition, glottal stops have been observed in normally developing children (Hodson and Paden, 1981; Ingram, 1976), but are reported to disappear in the early stages of phonological acquisition.

Sherman et al. (1959) observed that while glottal articulations may occur in the presence of velopharyngeal incompetence, the latter is not necessarily the cause of glottal articulation. Evidence for this observation stems from three sources. Clinical experience and research has often indicated that many children with cleft palate do not develop compensatory glottal stop articulation. This observation was borne out in the present study, in that only four of the eight subjects used glottal replacement productively (Fig. 14). Furthermore, glottal stops have been reported in descriptions of the speech of phonologically disordered children who show no incompetence of the velopharyngeal mechanism (Grunwell, 1981; Hodson and Paden, 1981; Schwartz, Leonard, Folger and Wilcox, 1980). Shriberg and Smith (1980) found strong evidence of glottal replacement in phonologically impaired children, who had no velopharyngeal incompetence, but who had histories of recurrent otitis media.

It would appear that three features distinguish the occurrence of glottal replacement in cleft palate and normal or phonologically

disordered children. Firstly, glottal stops occur more frequently and more conspicuously in the speech of cleft palate speakers than in the structurally normal population (Bzoch, 1965, 1979; Moll, 1968; Sherman et al. 1959). Secondly, the occurrence of glottal replacement in normally developing and phonologically disordered populations is confined to syllable final or intervocalic position and most often affects stop consonants (Edwards and Shriberg, 1983; Grunwell, 1981). In contrast, as mentioned previously, glottal replacement in the subjects of the present study occurred in all syllable positions and affected stops, fricatives and affricates. Thirdly, while glottal replacement is a feature of early phonological development and is suppressed by age three (Hodson and Paden, 1981), this process persists in the cleft palate population. Glottal stops are frequently characteristic of the speech of cleft palate speakers even after they have the physical ability to produce oral pressure consonants (Morris, 1979).

By virtue of the number of feature contrasts neutralised by glottal replacement, this process can be classified as broad in its application. The effects of glottal replacement on intelligibility are devastating, since the number of homonymous forms increases with the pervasiveness of the process. Subjectively, the speech production of the three subjects who gave strong evidence of glottal replacement presented the most difficulty in transcription, because of low intelligibility despite the fact that the transcribers were aware of the stimuli which elicited the responses.

#### Summary of description of substitution processes

Eight substitution processes were observed in the speech output of the present subjects. These processes varied both in the frequency of occurrence and the manner in which they were applied.

Certain of the processes observed, for example, liquid simplification and labialisation may possibly be regarded as evidence of normal

phonological acquisition as the segments affected by these processes are acquired late in the acquisition schedule in normally developing children. Other processes, as defined in the present study, seemed to indicate deviant phonological patterns uncommon in the speech of phonologically unimpaired children. These processes, such as palatalisation, non-sibilant replacement, velarisation, and glottal replacement all affected the feature contrasts of pressure consonants.

A further point of interest which emerged from the discussion presented above concerns the observation that not all sound changes, despite their systematicity can be accurately labeled as phonological processes. In order to determine the precise role of these sound changes in the phonological systems of the subjects, careful analyses of individual subjects are required. This important issue receives further attention in Chapter 7 and again in the general discussion (Chapter 8).

#### 8. Syllable structure processes

Two syllable structure processes met the criteria for process occurrence, namely cluster reduction and final consonant deletion (Fig. 13).

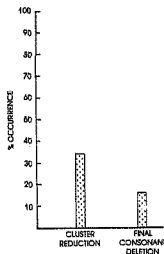


Fig. 13: Average percentage frequency of occurrence of syllable structure processes in connected speech samples

Fig. 13 reveals that the average percentage occurrence for cluster reduction was 34% and that for final consonant deletion was 16%. The inclusion of final consonant deletion was motivated by the fact that this process was productive in one subject (JM).

#### 1. Cluster reduction (CR)

Cluster reduction was the most frequently occurring syllable structure process and was observed in all subjects ranging from 14 - 61% occurrence (Fig. 14).

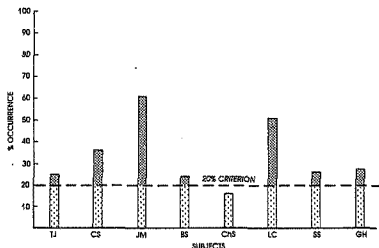


Fig. 14: Percentage of occurrence of cluster reduction for each subject

Cluster reduction affected both syllable initial (/s/ + stop and obstruent + approximant clusters) and syllable final clusters (nasal + obstruent and obstruent + obstruent clusters).

#### a. Syllable Initial Clusters

##### i. /s/ + stop clusters (oral and nasal)

Of all consonant clusters, /s/ + stop clusters were most frequently reduced by seven subjects. Subject (BS) tended to reduce syllable initial clusters infrequently.



Corresponding with the pattern of cluster reduction in normally developing children (Dunn and Davis, 1983; Grunwell, 1981; Ingram, 1976; Weiner, 1979), four subjects reduced /s/ + stop clusters by deleting the /s/ element (or the marked member of the cluster, i.e. that which was more difficult to produce). The stop element of the cluster was retained in some form. For example,

star [2a:]	small [mɔ:l]
spider [pʌsə]	snake [nɔ:k]

The pattern of /s/ + stop cluster reduction was ambiguous in two subjects (JM and LC) who used glottal replacement extensively as a single consonant (either /h/ or /ʔ/ replaced the consonant cluster). This pattern was consistent for two and three-element clusters. For example,

basket [bɑ:həh]	spoon [2u:n]
squirrel [hmawo]	icecream [āɪɪɪ:m]

Three-element clusters were more frequently reduced by all subjects than two-element clusters. This may be accounted for by the increased articulatory complexity inherent in three element consonant sequences (Morris et al., 1961). This patterns of cluster reduction is common in normal phonological development and may be expected to be present in children of four years (Grunwell, 1981).

#### ii. Obstruent + approximant clusters

As a group, obstruent + approximant clusters were infrequently reduced. With the exception of JM, all subjects retained the obstruent member of the cluster and deleted the approximant. For example,

slipper [ʒa?pə]	Tracy [ʔnāl?nɪ]
swimming [ʃəmɪŋ]	blue [bu:]
fruit [fu:c]	zebra [ʒəbʌ]

This pattern of reduction has been reported by several researchers in normal and phonologically impaired children of similar age range to that of the subjects of the present study

(Edwards and Shriberg, 1983; Grunwell, 1981; Hodson and Paden, 1981; Weiner, 1979).

JM displayed the reverse trend, i.e. the approximant member of the cluster was retained and the obstruent was deleted. For example,

slide	[wāl]	angry	[æŋwi]
flower	[wāuwa]	blue	[wu:]
drinking	[wĩŋkĩŋ]	crayon	[wāĩjŋ]

The marginal frequency of occurrence of obstruent + approximant cluster reduction may be attributed to the frequent observation that by age four years in normally developing children, most consonant clusters are correctly produced (Grunwell, 1981; Hodson and Paden, 1981). The fact that /s/ + stop clusters were more frequently reduced than obstruent + approximant clusters, most probably relates to the increased phonetic complexity associated with the production of these clusters.

#### b. Syllable Final Clusters

Two categories of syllable final clusters underwent the process of cluster reduction, namely nasal + obstruent clusters and obstruent + obstruent clusters. All subjects showed evidence of reducing both categories of syllable final clusters. Obstruent + obstruent clusters were more frequently reduced than nasal + obstruent clusters.

##### i. Nasal + obstruent clusters

The nasal element of the cluster was retained by all but two subjects. For example,

standing	[çʔæn]	orange	[owĩn]
went	[wen]		

This is in line with the pattern frequently reported in the literature on normally developing children (Weiner, 1979).

The obstruent member of the cluster was retained and the nasal was deleted by the remaining two subjects GH and TJ. For example,

crayons [ʔrəl.jəθ]

mans [mæ:θ]

ramp [wæp]

candles [kændəlɔ]

It is possible however, that in the latter pattern, the vowel preceding the target nasal was nasalised as a compensatory simplification strategy. Because of the overriding presence of hypernasal vowel production in these subjects, this was not easily discernible.

#### ii. Obstruent + obstruent clusters

Variable patterns of obstruent + obstruent cluster reduction emerged from the data. Four subjects (ChS, GH, TJ, SS) retained the fricative element of the cluster and the stop was deleted. For example,

ghost [gəʔt]

disks [blɔk]

finished [fɪnɪʃ]

One subject (CS) tended to delete the fricative and retain the stop member of the cluster. For example,

lost [lɔt]

mask [mɑ:t]

wax [wɑt]

In most cases, JM deleted the final cluster entirely. Where it was spared however, his obstruent neutralising pattern in the form of /h/ was observed in place of the cluster. For example,

fixed [hɪ]

nest [neh]

eggs [eh]

The remaining two subjects (BS and LC) showed no definitive pattern of obstruent + obstruent cluster reduction. With these two, either the fricative or the stop was retained or deleted in a seemingly random fashion.

Limited information is available about the production of syllable final clusters both in normal and cleft palate populations. Therefore, the explanations offered are only speculative. It has been documented that cleft palate speakers experience greater difficulty

with consonants in word final position than in word initial position (Fletcher, 1978; Moll, 1968; Philips and Harrison, 1969).

Furthermore, consonant clusters in general, require a greater degree of articulatory control and precision than singletons and probably more so in final position (Stoel-Gammon and Dunn, 1985). This seems especially relevant in the presence of velopharyngeal incompetence and reduced intraoral breath pressure.

Available research data concerning the production of consonant clusters in general in the cleft palate population is limited to the description of general trends. Neither the influence of word or syllable position on clusters nor the pattern of cluster reduction has been specified. Researchers are in agreement that clusters present greater difficulty for the cleft palate speaker than singleton consonants. Fletcher (1978) found the most frequently misarticulated clusters were those involving /s/. Priestestersbach, Darley and Rouse (1956) suggested that since consonant clusters require "rapid and precise" articulation, they tax the speaker's ability to compensate for physical deformities.

The presence of cluster reduction in this four year old group suggests delay in terms of what is expected of normal children of the same age group. Shriberg and Kwiatkowski (1980) reported 90% correct cluster production in normal children by age four years and Hodson and Paden (1981) found no evidence of cluster reduction in the normal four year old subjects they evaluated.

## 2. Final consonant deletion (FCD)

All subjects deleted final consonants in the range 3% - 39% (Fig. 15). However, this process met the specified criteria for process occurrence in only two subjects (BS and JM).

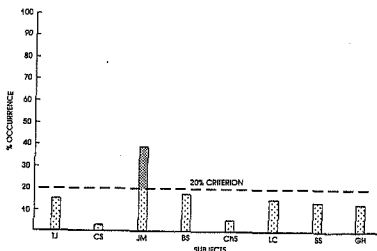


Fig. 15: Percentage of occurrence of final consonant deletion for each subject

Of the obstruents affected by final consonant deletion, stops were more frequently deleted than fricatives or affricates. Furthermore, voiceless consonants were more commonly deleted than voiced consonants. When the entire consonant range was examined, it became evident that word final nasals were the segments most often affected by final consonant deletion. It is possible that the percentage of final consonant deletion of nasals would have been lower had it been possible to detect the presence of compensatory nasalisation of the preceding vowel.

In summary therefore, final consonant deletion was productive in only two subjects, and when it did occur the percentage of occurrence was low. The overall absence of final consonant deletion was anticipated in view of the fact that final consonant deletion is a process which is suppressed between 1;6 and 3 years in children with normally developing phonology (Dyson and Paden, 1983; Grunwell, 1982; Ingram, 1974; Khan et al, 1983). The persistence of FCD beyond age three has been associated with phonologically impaired children (Grunwell, 1981; Hodson and Paden, 1981; Khan et al, 1983).

Although the presence of final consonant deletion has been interpreted as reflecting an underlying disorder of the phonological system, its foundation could lie in phonetic causes, particularly in the cleft palate population. McWilliams et al. (1984) have postulated that in the presence of velopharyngeal incompetence, the final obstruents could be deleted in an attempt to avoid nasal emission or that available air pressure is dissipated in word final position. Furthermore, transcriptions from tape recorded speech samples may obscure detection of final consonants, particularly in the case of weak or silent articulations.

#### Summary of Syllable Structure Processes

The findings presented above indicate that most subjects preserved the syllable structure in the majority of target words. The one exception was the presence of the process of cluster reduction which was observed to occur frequently in some subjects. The finding of low frequency of occurrence of syllable structure processes is consistent with research on children with normally developing phonology who have been shown to have established underlying phonological knowledge of syllable shapes and structure early in phonological acquisition.

#### C. Assimilation processes

Although the opportunities for assimilation processes to occur in the data were numerous, very few examples of these processes occurred. No subject used assimilation processes in more than five instances; therefore this category of processes did not reach criterion. Of those instances which did occur, labial assimilation was most frequent, followed by nasal assimilation, alveopalatal assimilation and velar assimilation.

The fact that assimilation processes did not meet the criteria for process occurrence has important implications in terms of the description of the speech of the present subjects as phonologically delayed or deviant. According to Grunwell (1982) and Ingram (1976),

assimilation is a process which occurs in the earliest stages of phonological acquisition and disappears by approximately age three. The paucity of assimilation processes in the present data lends support to an overall impression of normal phonological development, at least with regard to the effects of one sound segment in relation to others in the same word.

### III. SUMMARY OF RESULTS OF PHONOLOGICAL PROCESS ANALYSIS

Eleven phonological processes, which fulfilled the qualitative and quantitative criteria for process occurrence were observed in the naming and connected speech samples. An additional eight processes were identified but these failed to meet the quantitative criterion of 20% and were thus considered marginal.

The predominant finding emerging from the results of the phonological process analysis was inter-subject variability with regard to the nature of the phonological processes observed, their frequency of occurrence and the manner in which they were applied. Despite the variability, certain broad trends emerged.

Of the three categories of phonological processes, substitution processes occurred more frequently than syllable structure processes or assimilation processes. Thus simplifications of adult target words were mostly evident at the systemic level of speech production and not at level of syllable structure. Within the category of substitution processes, those which affected the phonemic contrasts of obstruents were most common, for example, deaffrication, palatalisation, non-sibilant replacement and glottal replacement. This finding confirms the well known phenomenon of poor pressure consonant production in children with cleft palate.

In the main, the percentage frequency of occurrence of phonological processes was low. None of the phonological processes were applied obligatorily by the subjects, i.e. in 100% of all potential occurrences. Many of the processes occurred in approximately 30%-50%

of opportunities, although certain processes (e.g. glottal replacement, palatalisation) were applied extensively by selected subjects.

Of the phonological processes observed, seven have been reported in the speech of children with normally developing phonology, for example, liquid simplification, labialisation, deaffrication, cluster reduction. The subjects of the present study are distinguished from normally developing children in that by age 4 years, most phonological processes should be suppressed (Grunwell, 1981; Khan et al., 1983; Shriberg and Kwiatkowski, 1980; Stoel-Gammon and Dunn, 1985). The remaining four processes seemed to be indicative of deviant phonological patterns. Non-sibilant replacement, glottal replacement and palatalisation as defined in the present study have not, to the writer's knowledge, been described in the speech of normally developing children nor in the speech of non-cleft phonologically deviant children. In contrast, the presence of velarisation has been noted in the speech of phonologically deviant children.

Although phonological processes described many of the subjects' errors of speech sound production, certain errors could not be accounted for in these terms. This is reflected in the low frequency of occurrence of phonological processes in relation to the severity rating of "moderate-severe" to "severe" obtained in the calculation of the percentages of consonants correct. Furthermore, while several errors were systematic, it was not always clear which errors resulted in a reduction in phonemic contrasts (phonological errors) and which were allophonic variants of the target sound (phonetic errors). In addition, certain errors, which could be described in phonological process terms did not fulfill the criteria for process occurrence and were omitted from the discussion in this chapter.

Having described the group trends with respect to phonological



process occurrence, the researcher was interested in examining each subject's phonological system to determine the effects of these processes on the use of the sounds in his phonetic repertoire. Therefore, in order to give a clinical perspective to the results of the phonological process analysis and to relate these findings to the subjects' phonetic capabilities and their case history information, the following chapter is presented. In this way it is possible to determine more precisely than by phonological process analysis alone, the extent to which the subjects showed features of phonetic and/or phonological disability.

## CHAPTER 7

### RESULTS AND DISCUSSION OF RESULTS - INDIVIDUAL ANALYSES

In the previous chapter, phonological process occurrence was described in terms of group trends and inter-subject performance. This chapter presents the results of the phonological analyses for individual subjects and attempts to integrate the findings of the phonetic inventory, contrastive assessment and the phonological process analysis with relevant case history information.

The individual phonological analyses are based on the same speech production data obtained from the naming and connected speech tasks described in Chapter 5. The following aspects of phonological functioning are incorporated into the discussion for each subject and are summarised in Tables 10-17.

- Phonetic inventory which contains the repertoire of single consonants demonstrated by each subject without reference to the target sound.
- Systems of phonemic contrasts in syllable initial position and syllable final position displayed by each subject. These are based on the findings of the contrastive analysis (described in Chapter 5) and are graphically represented on item and replica charts.
- A summary of the phonological processes used by each subject, arranged according to frequency of occurrence (described in Chapter 6). Those processes which did not meet the quantitative criteria for process occurrence were not included in the discussion.
- Relevant case history information together with the findings of the examination of the oral mechanism are integrated with the results of the phonological analyses.

Table 10: Summary of phonetic inventory, contrastive phonemes and phonological processes for Subject TJ

# PHONETIC INVENTORY

NASALS	m n ŋ
STOPS/AFFRICATES	p b d k q ʔ
FRICATIVES	f v θ ð ʃ ʒ h ʁ
APPROXIMANTS	w r l j

## INVENTORY OF CONTRASTIVE PHONEMES

### ----- SYLLABLE INITIAL POSITION -----

ADULT	SUBJECT TJ																																																																																								
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### ----- SYLLABLE FINAL POSITION -----

ADULT	SUBJECT TJ																																																																
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## PHONOLOGICAL PROCESSES

GLOTTAL REPLACEMENT	79
NON-SIBILANT REPLACEMENT	62
DEVOICING OF FINAL CONSONANTS	62
DEAFFRICATION	57
LABIALISATION	38
CLUSTER REDUCTION	25

SUBJECT TJ

Table 10 indicates that TJ's phonetic repertoire comprised 17 of the 24 possible English consonants. With the exception of affricates, TJ produced all manner classes. The full quota of nasal and approximant consonants were represented. Both voiced and voiceless consonants were produced, however, more voiceless than voiced fricatives were observed. All features, except for alveolars were produced. TJ's phonetic repertoire contained a variety of non-English obstruents. These included the post-velar stops, [q], [ɣ], [ʁ], [ʔ], palatal fricatives [ç], [j] and the posterior nasal fricative [ɲ].

Despite TJ's physical ability to produce the consonants in the phonetic inventory described above, these consonants were not always used to signal meaning differences (Table 10). In both syllable positions, nasal and approximant sound classes were used contrastively. No voicing distinction between voiced and voiceless obstruents was maintained. In syllable initial position, with the exception of /b/, all obstruents were replaced by glottal stops. This effectively collapsed the obstruent manner and place contrasts. The phonemes /d/ and /ʒ/, were sometimes produced as [g] or [ʒ] respectively; however, the glottal stop remained the canonical phoneme.

A wider range of contrastive phonemes occurred in syllable final than in syllable initial position. In syllable final position, TJ made the distinction, albeit rudimentary, between [ $\pm$ continuant] (Table 10). With regard to place of articulation in syllable final position, it appeared that TJ made a broad distinction between [ $\pm$ labial], where [+labial] included labial and dental obstruents (realised as [p] or [f]) and [-labial] included all obstruents produced at the alveolar ridge and posteriorly (realised as [θ] or [ð]).

The marked reduction in phonemic contrasts in both syllable positions can be described in terms of three substitution phonological

processes which occurred in more than 60% of potential occurrences: glottal replacement (79%), non-sibilant replacement (62) and devoicing of final consonants (62). On the whole, all elements of consonant clusters were produced in some form, even though the same substitution processes which applied to the production of single consonants also affected individual elements of the clusters. This finding was reflected in the relatively low occurrence of cluster reduction, indicated in Table 10.

The findings of the clinical examination of TJ's oral speech mechanism (Table 5) revealed strong evidence of velopharyngeal incompetence. The soft palate was extremely short in relation to the depth of the pharynx and no obvious movement of the soft palate was observed on the production of /a/. This, however, does not exclude the possibility of compensatory lateral or posterior pharyngeal wall movement, not visible from this examination. The effects of velopharyngeal incompetence were also observed in the production of obstruent consonants which were often nasally emitted.

The results of the phonological analysis for TJ clearly illustrate the co-existence of a phonetic and phonological disorder in this subject. The observation that TJ did not produce certain English sounds expected for his age, combined with his functionally incompetent velopharyngeal mechanism would seem to implicate a disorder at the phonetic level. However, TJ's phonetic inventory indicated that he had the physical ability to produce several consonants which he was unable to use contrastively. This inability to signal meaning differences among the phonemes of English lends support to a diagnosis of phonological disability, as defined in the present study.

When the phonological component of TJ's speech sound production disorder is considered further, it is evident that this subject displays a mixed picture of both phonological delay and phonological

deviance. A diagnosis of phonological delay is supported by the occurrence of four phonological processes (devoicing of final consonants, deaffrication, labialisation and cluster reduction) all of which have been reported in the speech of normally developing children. In addition, the far reaching effects of glottal replacement and non-sibilant replacement on the phonological system would indicate phonological deviance.

#### SUBJECT CS

Of all subjects, CS had the most complete consonant inventory, in which all 24 English consonants were produced at least some of the time (Table 11, below). All manner, place and voicing features were present in CS's consonant inventory. In addition to the English consonants, CS also used non-English consonants, such as palatal stops, fricatives and affricates and glottal stops.

CS's system of phonemic contrasts closely approximated that of adult English. Nasal and approximant consonants were phonemically contrastive in both syllable positions. With the exception of alveolar fricatives, all English phonemes were used contrastively in syllable initial position. In some cases, the phonetic realisation of the target sound was a non-English consonant, e.g. [ç] replaced /ʃ/ and [çʃ] replaced /tʃ/. However, these errors may be referred to as sound substitutions or instances of phonetic distortion since the substitution was isomorphic with the target sound and did not alter its meaning value.

Fewer consonants were contrastive in syllable final than in initial position. In particular, the voicing contrast of obstruent sounds was lost which was described as the phonological process of devoicing of final consonants. The place contrasts in syllable final position were maintained for all stop/affricate consonants. However, fricatives, particularly alveolar fricatives, showed loss of the place, manner and voicing contrasts (Table 11), i.e. interdental and alveolar

Table 11: Summary of phonetic inventory, contrastive phonemes and phonological process occurrence for subject CS

PHONETIC INVENTORY	
NASALS	m n ŋ
STOPS/AFFRICATES	p b t d k tʃ dʒ c ʃ ʒ ʃʃ k ɡ ʔ
FRICATIVES	f v θ ð s z ʃ ʒ ɣ h
APPROXIMANTS	w r l ɹ j

INVENTORY OF CONTRASTIVE PHONEMES	
----- SYLLABLE INITIAL POSITION -----	
ADULT	SUBJECT CS
----- SYLLABLE FINAL POSITION -----	
ADULT	SUBJECT CS
PHONOLOGICAL PROCESSES	
NON-SIBILANT REPLACEMENT	57
DEVOICING OF FINAL CONSONANTS	53
LABIALISATION	43
CLUSTER REDUCTION	36

fricatives were replaced by labiodental or interdental fricatives respectively. In the previous chapter, the substitution of alveolar and interdental fricatives was described in terms of the phonological processes non-sibilant replacement and labialisation, respectively. However in this subject, labelling these sound substitutions as phonological processes is questionable. In each case, only one cognate pair of contrasts was collapsed; thus the specified qualitative criteria for phonological process occurrence were not met. Therefore, even though these errors occurred systematically and frequently in CS's speech, it would seem more accurate to describe them as two independent sound substitutions than as phonological processes. The only sound changes which met the criteria for process occurrence were devoicing of final consonants and cluster reduction.

CS had a bilateral cleft lip and palate and a history of chronic middle ear infections. Primary palatal repair was conducted at 18 months of age and ventilation tubes were inserted on several occasions to manage the otitis media. The observation that this subject's speech production skills were superior to those of the other subjects in the present study, was contrary to the findings in the literature which predict a direct relationship between severity of cleft and speech performance and allude to possible negative effects of middle ear pathology on speech sound development. Factors which may have contributed to the relatively good speech production skills in this subject include the status of his oral structural mechanism and function thereof (the clinical examination of the oral mechanism revealed no gross functional anomalies), his age (CS was the oldest of the subjects), and the fact that he had received speech therapy intermittently for two years.

In summary, CS appeared to be in the process of consolidating his productive phonological system. Those errors of speech sound production which were observed were either phonetic in nature or fell



within upper limits of the normal range for his chronological age. No overt evidence emerged which would support a diagnosis of phonological delay or deviance in this subject.

SUBJECT JM

Table 12, below, reveals that JM had a severely impaired phonological system. His phonetic repertoire was extremely restricted comprising only 16 consonants, two of which were non-English phones. Complete absence of alveolar stops, fricatives and alveopalatal affricates was noted. However, all nasals and approximants were produced correctly, at least three times in the samples.

As would be predicted from the reduced phonetic inventory, JM's range of phonemic contrasts was severely restricted. In syllable initial position, the extensive use of /h/ for obstruents (described as the process of glottal replacement) merged several manner, place and voicing contrasts. JM failed to distinguish stops from affricates or fricatives, and glides were not held distinct from liquids. The place distinction for labial and labiodental obstruents was maintained, but that of obstruents produced more posteriorly was weakened to the glottal fricative /h/. A primitive voicing distinction was observed for labiodental and alveolar fricatives in that voiceless targets were replaced by /h/ and voiced targets by /w/.

In syllable final position, the same place distinction was maintained for anterior obstruents as occurred in syllable initial position. However, post-alveolar obstruents were, in many cases, deleted entirely or were weakened to /h/. No voicing distinction was evident in this syllable position and is reflected in the high frequency of the process of devoicing of final consonants.

JM had an incomplete cleft of the hard and soft palates which was repaired in a one-stage procedure at 10 months of age. A history of otitis media was reported by his mother, and ventilation tubes were inserted on two occasions. The examination of JM's oral mechanism

Table 12: Summary of phonetic inventory, contrastive phonemes and phonological process occurrence for subject JM

PHONETIC INVENTORY	
NASALS	m n ŋ
STOPS/AFFRICATES	p b k ʔ
FRICATIVES	f v ʃ ʒ h
APPROXIMANTS	w r l j

INVENTORY OF CONTRASTIVE PHONEMES	
----- SYLLABLE INITIAL POSITION -----	
ADULT	SUBJECT JM
----- SYLLABLE FINAL POSITION -----	
ADULT	SUBJECT JM
PHONOLOGICAL PROCESSES	
GLOTTAL REPLACEMENT	90
CLUSTER REDUCTION	61
GLIDING OF LIQUIDS	51
FINAL CONSONANT DELETION	51

revealed no gross abnormalities. Although the examination was brief and observational in nature, no evidence of gross velopharyngeal incompetence was obvious. Symmetrical velar movement was observed in the production of /a/. The interpretation of this finding must be made with caution as precise movements of the velopharyngeal mechanism can only be accurately evaluated with the aid of instrumentation designed for that purpose, viz. videofluoroscopy and/or fibreoptic nasendoscopy. Furthermore, the possibility of subtle neuromotor deficiency in relation to tongue and velar musculature cannot be excluded.

In fact that JM's phonetic inventory did not contain all English consonants seems to implicate phonetic factors as the cause of his poor speech intelligibility. Detailed investigation would be required to ascertain which aspects of oral structure and functioning are responsible. Even though the underlying cause of JM's speech disorder may be phonetic, the extensive and systematic use of glottal replacement and deletion processes hampered his ability to make the meaning differences among the consonants of English.

Therefore it is suggested, in the light of the findings presented above that JM displays a severe phonological disability. Further testing, such as phonemic perception and stimulability testing, would be required to determine the cause of the phonological disorder as either phonetically-based, the result of phonological impairment at a neuropsycholinguistic level or a combination.

#### SUBJECT BS

In Table 13 above, it is evident that considerable phonetic variability characterised this subject's production and contributed appreciably to her unintelligibility. While it is recognised that transcription time does not accurately reflect intelligibility, the phonetic transcription of BS's speech samples took the longest of all

subjects. This was primarily due to the variability and apparent lack of systematicity in the production of consonants, particularly obstruents.

BS was capable of producing 17 English consonants. With the exception of alveolar nasals and approximants, tongue tip sounds were almost completely absent. These consonants were supplemented by the production of a wide range of compensatory consonants, such as uvular, pharyngeal and glottal stops as well as palatal articulations. The posterior nasal fricative [ɤ] and the laterally released voiceless fricative [ɬ] made up the remainder of the non-English consonant sounds.

Because of the extreme variability, it was difficult to establish the inventory of contrastive phonemes for BS. The principle which determined the presence of a canonical form for a particular phoneme in all contrastive analyses, was to select that substitution which occurred most frequently or consistently. This principle had limited application for this particular subject as the phonetic manifestations for the same phoneme were numerous and in many cases occurred with equal frequency. For example in syllable initial position /t/ was replaced by [ʔ] seven times, [c] 5 times, [k] five times and [t] four times.

Phonological process analysis failed to account for the extreme variability in production of stops and fricatives. For example, BS produced the voiced and voiceless alveolar and alveopalatal fricatives as [c, ɤ, ɬ and ʃ] in an equal number of cases for these target phonemes, resulting in confusion about the status of the canonical form. Because the phonemic contrasts between these four independent phonemes were lost, the error could be defined as phonological, at least on a productive level. The identification of a single pattern in these error forms was ambiguous. Examination of the errors revealed that the distinctive features [+continuant]

w r i . i

63  
63  
53  
43  
24  
24

[+strident] were maintained, but that the voicing and place features were lost. When the loss of the place contrast was considered, the following options were possible: either the operative phonological process was palatalisation - this would take account of the production of /ç, ʃ/ but would not explain the other errors; or the operative process was backing - this would explain the errors /ç, ʃ, and perhaps Δ/ but would not account for the production of the lateral alveolar fricative /ɬ/. For convenience, it was decided to use both processes which described each error form, so that /ç/ for /s, z, ʃ and ʒ/ would be regarded as reflecting palatalisation, and /ɬ/ was described as lateralisation, and so on. However, this solution was unsatisfactory as it did not capture the underlying pattern in the production of the error form.

The contrastive analysis for BS revealed extreme variability of the type described above, particularly with regard to post-alveolar obstruents (Table 13). Variability appeared to occur more frequently in syllable initial than in syllable final positions. According to Grunwell (1981) variability of this nature may suggest phonological deviance as few phonetically different segments have been stabilised as contrastive phonemes. In spite of the variability, however, rudimentary place, manner and voicing distinctions are observed (the latter in syllable initial position only). Thus, labial and labiodental obstruents were held distinct from post-alveolar obstruents, continuants were held distinct from non-continuants and voiced were distinct from voiceless obstruents. The loss of contrast between alveolar and velar stops was described in terms of the phonological process of velarisation, uncommon in normal phonological development.

BS had an incomplete cleft of the hard and soft palates, which was surgically repaired in a two stage procedure. The soft palate was repaired at 13 months and the hard palate at 36 months. The examination of the oral mechanism indicated an absence of movement of

the soft palate on the production of /a/. Nasal emission particularly on voiceless obstruents provided further evidence for velopharyngeal incompetence. BS suffered from numerous episodes of otitis media which were managed conservatively due to a concomitant medical condition which was reported to be associated with anaesthetic risk. While only speculative, it was possible that the relatively late surgical repair of the palate, the presence of frequent middle ear disease and episodes of fluctuating hearing loss may have contributed to the degree of impairment in speech sound production.

Thus, BS illustrates the co-existence of phonetic and phonological deviance in a single child. Although certain simplification processes were indicative of phonological delay, her extreme variability in speech sound production and apparently unstable system of contrasts provide evidence for phonological deviance.

#### SUBJECT ChS

ChS's phonetic inventory comprised 20 of the 24 English segments. Voiced alveolar stops, fricatives and affricates were absent as was the voiceless affricate /tʃ/. In addition to the English consonants, ChS displayed a wide range of non-English consonants, such as palatal articulations, glottal stops and posterior nasal fricatives (Table 14).

It is interesting to note that despite the wide range of English consonants in her phonetic inventory, these were not used contrastively in all cases (Table 14). Instead a tendency for non-English phonetic realisation of target English phonemes was observed. ChS showed a discrepancy between the number and nature of contrastive phonemes occurring in syllable initial and syllable final positions. For example, the contrasts between alveolar stops and alveopalatal affricates evident in syllable initial position were absent in syllable final position. The same was true for the obstruent voicing distinctions in the two syllable positions. Thus, ChS's system of contrasts in syllable initial position was more sophisticated or

Table 14: Summary of phonetic inventory, contrastive phonemes and phonological processes for subject ChS

## PHONETIC INVENTORY

### NASALS

m n ŋ

### STOPS/AFFRICATES

p b t c ʃ cʃ ʒ ʒ k g ʔ

### FRICATIVES

f v θ ð s ʃ z ɹ h ʌ

### APPROXIMANTS

w r l j

## INVENTORY OF CONTRASTIVE PHONEMES

### ----- SYLLABLE INITIAL POSITION -----

#### ADULT

m		n							
p	b		t	d	ʈ	ɖ	k	g	
		f	v	s	z	ʃ			h
		θ	ð						
w				r		j			

#### SUBJECT ChS

m		n							
p	b		t	ʔ	cʃ	ʒ	k	g	
			(c)	(ʔ)			(2)		
		f	v	ɹ	j	ɹ			h
		θ	ð						
w				w(r)		j			
				1					

### ----- SYLLABLE FINAL POSITION -----

#### ADULT

m		n				ŋ		
p	b		t	d	ʈ	ɖ	k	g
		f	v	s	z	ʃ	ʒ	
		θ	ð					
						1		

#### SUBJECT ChS

m		n				n(ŋ)	
p	b		(c)	(c)	cʃ	k	k
						(2)	(g)
		f	ɹ	ɹ			
				1			

## PHONOLOGICAL PROCESSES

DEVOICING OF FINAL CONSONANTS

81

LABIALISATION

75

PALATALIZATION

63

DEAFFRICATION

31

GLOTTAL REPLACEMENT

28

SLIDING OF LIQUIDS

28



adult-like than that in syllable final position.

It is interesting to note that in syllable initial position, ChS was able to establish meaningful contrasts for stops and affricates even though their phonetic realisation was not always accurate in terms of the target utterance. For example, /t/ was realised as [t] or [c], /d/ as [ʃ] or [ʒ], /t/ as [cc] and /dʒ/ as [ʃʃ]. This illustrates the inappropriateness of assigning the process of palatalization to the errors of articulation in which alveolar stops, fricatives and alveopalatal affricates were replaced by palatal consonants. Instead, the substitutions used by ChS in this context are evidence of a phonetic disorder as they were isomorphic with the target sound. In syllable final position, however, the description of replacement of palatal for alveolar and alveopalatal fricatives is appropriate because of the reduction in phonemic contrast between these classes of sounds.

The phonological process which accounted for the majority of the reduction of syllable final contrasts was that of devoicing of final consonants. This was observed in 81% of possible occurrences of the process. Since this process affects a large number of potential contrasts, its consequences were far reaching. Other phonological processes which contributed to the reduction of the system of phonemic contrasts especially those in syllable final position included labialisation, deaffrication, glottal replacement and gliding of liquids. These affected only a small number of contrasts (on average two per process), hence minimal influence on the phonological system as a whole was observed.

The presence of a small anterior oronasal fistula and the orthodontic appliance fitted for the expansion of malaligned dental arches were the two outstanding features of the oral structure which may have accounted in part for the articulation disorder. The effects of an oronasal fistula on speech production have received limited attention

in the literature. Cosman and Falk (1980) noted that children with residual clefts of the hard palate following primary palatal repair tended to use the correct manner of articulation, but to shift their production to a posterior placement. The presence of frequent palatal productions in this subject supports this finding.

The speech sound production data for ChS provides a further example of co-existing phonetic and phonological errors. While phonetic errors were more common in syllable initial position, it appeared that ChS was unable to make the same number of phonological contrasts in syllable final position. The fact that ChS's phonetic inventory comprised correct production of several English consonants (such as [s, ʃ and ʒ]) which were not used contrastively may be suggestive of progressive variability (Grunwell, 1981) common in normally developing children.

#### SUBJECT LC

19 English segments comprised LC's phonetic inventory (Table 15). All stops, nasals and approximants were represented. Noteworthy is the general absence of sibilant phones; only /ʃ/ was present. Affricates were never produced in any form. Two non-English consonants were observed, namely glottal stops and the uvular stop [q]. Glottal stops occurred either as a single articulation or coarticulated with an oral consonant.

LC's system of phonemic contrasts in both syllable positions is suggestive of severe phonological deviance. In syllable initial position, with the exception of the voiceless dental fricatives, all obstruents were replaced either by single glottal stops or glottal stops coarticulated with an oral consonant. This loss of contrast was described as the phonological process of glottal replacement. However, within this aberrant pattern a crude, binary place distinction was apparent. Labial and labiodental phones were made distinct from alveolar and post-alveolar phones in that [ʔ]

Table 15: Summary of phonetic inventory, phonemic contrasts and phonological processes for subject LC

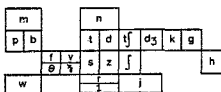
## PHONETIC INVENTORY

NASALS	m n ŋ
STOPS/AFFRICATES	p b t d k g ʈ ɖ (ʈ+ç)
FRICATIVES	f v θ ð ʃ h
APPROXIMANTS	w r ɹ j

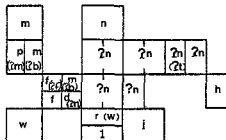
## INVENTORY OF CONTRASTIVE PHONEMES

## SYLLABLE INITIAL POSITION

ADULT

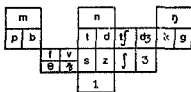


SUBJECT LC

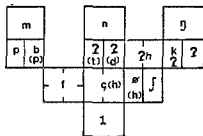


## - SYLLABLE FINAL POSITION

ADULT



SUBJECT LC



## PHONOLOGICAL PROCESSES

GLOTTAL REPLACEMENT	78
CLUSTER REDUCTION	51
DEVOICING OF FINAL CONSONANTS	41
GLIDING OF LIQUIDS	20

coarticulated with a labial consonant replaced anterior phones and [ɹ] coarticulated with an alveolar consonant replaced phones produced at the alveolar ridge or posteriorly. Furthermore, the rudiments of a voicing distinction were apparent in syllable initial labial and dental phones; voiced phones were indicated by the coarticulation of glottal and nasal consonants and voiceless phones were indicated by the coarticulation of glottal and voiceless labial obstruents.

Fewer and different phonemic contrasts were observed in syllable final position than in syllable initial position. While glottal coarticulation was frequently observed in syllable initial position, the glottal stop was produced as a single articulation in syllable final position. In addition, in syllable final position, glottal stops only replaced stop consonants, whereas in syllable initial position, glottals replaced all obstruents. Thus it appeared that LC was able to signal a [±continuant] distinction in syllable final position which was absent in syllable initial position.

The collapse of the major sound classes in this subject was accounted for by the presence of glottal replacement and devoicing of final consonants. The high frequency of occurrence of these processes resulted in several homonymous forms and rendered LC's speech unintelligible.

LC had a small anterior oronasal fistula which was deliberately left by the surgeon to facilitate growth of the palatal shelves. Subjective examination of the oral mechanism revealed a short soft palate in relation to the depth of the pharynx. This was confirmed by lateral and submento-vertical videofluoroscopic studies which were subsequently available to the writer. According to the radiologist's report, the lateral view revealed marginal approximation of the soft palate against the posterior pharyngeal wall and the submento-vertical view indicated considerable excursion of the lateral pharyngeal walls.

Although it is possible that deviant oral structure and function was, at least in part, responsible for LC's disordered speech sound production, this had the effect of reducing LC's ability to signal the contrasts between the manner and place distinctions of English. Reduction in phonemic contrasts as was displayed by this subject seems suggestive of phonological deviance.

#### SUBJECT SS

Together with subject CS, SS displayed the mildest errors of speech production, many of which could be considered within normal limits for her age. All but three English consonants ([tʃ], [ʒ] and [x] were contained in SS's phonetic inventory. The only occurring non-English consonant was [ʔ] (Table 16).

All stop consonants were contrastive in both syllable positions, however, affricates were most often replaced by alveolar stops in syllable initial position. All fricatives were replaced by labial or interdental fricatives, and no sibilant/non-sibilant contrast was noted. The liquid /r/ in syllable initial position was non-contrastive and was described in terms of the process of liquid simplification.

The findings of the examination of SS's oral structure and function were generally unremarkable. In summary, the overall results of the phonological analyses in this subject reflected patterns usually associated with normally developing children rather than with deviations associated with organic pathology.

SUBJECT SS

Table 16: Summary of phonetic inventory, contrastive phonemes and phonological processes for subject SS

# PHONETIC INVENTORY

NASALS	m n ŋ
STOPS/AFFRICATES	p b t d d <sub>3</sub> k g ʔ
FRICATIVES	f v θ ð s z ʃ
APPROXIMANTS	w l j

## INVENTORY OF CONTRASTIVE PHONEMES

### ----- SYLLABLE INITIAL POSITION -----

#### ADULT

m		n						
p	b		t	d	tʃ	dʒ	k	g
		f	v	s	z	ʃ		h
w								

#### SUBJECT SS

m		n						
p	b		t	d	t	d	k	g
		f	w	θ	ð	θ		h
w								

### ----- SYLLABLE FINAL POSITION -----

#### ADULT

m		n		ŋ				
p	b		t	d	tʃ	dʒ	k	g
		f	v	s	z	ʃ	ʒ	

#### SUBJECT SS

m		n		ŋ				
p	b		t	d	tʃ	dʒ	k	g
		f	v	θ	ð	θ	ð	

## PHONOLOGICAL PROCESSES

NON-SIBILANT REPLACEMENT	65
LABIALISATION	47
GLIDING OF LIQUIDS	40
DEVOCING OF FINAL CONSONANTS	31
CLUSTER REDUCTION	26

SUBJECT GH

Table 17: Summary of phonetic inventory, contrastive phonemes and phonological processes for subject GK

### PHONETIC INVENTORY

## NASALS

□ □ □

## STOPS/AFFRICATES

p b t d d<sub>5</sub> c ʃ ĉç ʃĵ k g q 2

## FRICATIVES

f v θ x { 3 c j h

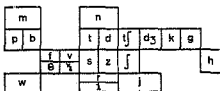
## APPROXIMANTS

w l j

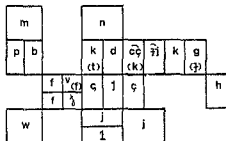
## INVENTORY OF CONTRASTIVE PHONEMES

## SYLLABLE INITIAL POSITION

## ADULT

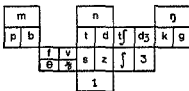


SUBJECT GH

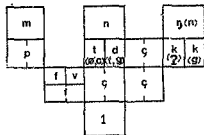


## - SYLLABLE FINAL POSITION

ADULT



SUBJECT, GH



## PHONOLOGICAL PROCESSES

GLIDING OF LIQUIDS  
PALATALISATION  
DEVOICING OF FINAL CONSONANTS  
DEAFFRICATION  
CLUSTER REDUCTION  
LABIALISATION

83  
80  
69  
63  
27  
27

The phonetic inventory for GH presented in Table 17 above, indicates minimal reduction in the number of English segments present. GH's English consonant phonetic repertoire was clearly supplemented by the use of non-English palatal articulations in all obstruent manner classes.

In spite of GH's physical ability to produce the above consonants correctly, only selected consonants were used contrastively. In syllable initial position, GH contrasted all stops and affricates; alveolar and alveopalatal fricatives, however, were non-contrastive and were replaced by palatal phones. This was accounted for by the phonological process of palatalisation. Glides and liquids were not always contrastive. A similar inventory of contrasts was evident in syllable final position, although in this position, affricates and alveolar and alveopalatal fricatives were non-contrastive. In syllable final position, GH failed to distinguish voiced from voiceless obstruents, the result of devoicing of final consonants.

The findings of the examination of the oral structure were compatible with velopharyngeal incompetence. GH had a short soft palate which moved only marginally on the production of /a/. Audible nasal escape was a frequent concomitant of obstruent production and vowels were nasalised. While the contribution of impaired oral structure and function in precipitating poor speech sound production cannot be denied, the role of habit strength and learning factors cannot be ignored. GH underwent surgery for hard palate repair at three years four months, the latest of all the subjects in the present study.

Analysis of the speech production data for GH seemed to suggest a combination of physical ability and elements of phonological delay and phonological variance. As with several of the other subjects described in this chapter, it is possible that deviant oral structure and function resulted in impaired ability to signal meaning differences in English.



SUMMARY OF INDIVIDUAL PHONOLOGICAL ANALYSES

The findings of the individual phonological analyses presented in this chapter revealed heterogeneous performance with regard to phonological patterning. Certain subjects (CS and SS) showed phonological patterns typical of those in children with normally developing phonology. Other subjects demonstrated delayed and/or deviant phonological development in terms of the phonological processes used to simplify the adult target phonemes. In several subjects, phonetic and phonological errors co-existed, an expected finding given the organic component underlying their disordered speech production.

All subjects showed a reduction in their ability to signal certain phonemic contrasts of English. Those most frequently affected were the phonological contrasts affecting obstruent consonants. In certain cases, oral structural impairment seemed responsible for reduced systems of phonemic contrasts at the level of speech output; in other cases, it appeared that a combination of learning and structural factors contributed to the speech sound production disorder.

## CHAPTER 8

### GENERAL DISCUSSION

The present study was concerned with the description of speech sound production errors of eight four year old children with repaired cleft palate in terms of phonological processes. When the results were presented, the nature of the phonological processes identified and their percentage frequency of occurrence were described; both group trends and inter-subject use of phonological processes were considered. In addition, an attempt was made to relate the findings of the phonological process analysis for individual subjects to their phonetic inventories, terms of phonemic contrasts, and relevant case history information.

This chapter serves to interpret the findings of the study drawing on previous literature in the fields of clinical phonology and cleft palate research. Specifically, the major findings are summarised in terms of the aim of the present study and the issue of whether or not the subjects demonstrate phonological disability is discussed. The role of their structural impairment and phonetic capabilities in relation to phonological disability, is examined. This chapter also explores the possible factors which accounted for the heterogeneity of the findings and discusses the limitations with regard to their generalisability. The applicability of phonological process analysis to the description of errors of speech sound production is discussed.

#### I. SUMMARY OF THE MAJOR FINDINGS OF THE PRESENT STUDY

Nineteen phonological processes were identified in connected speech samples of the eight subjects under study. While eleven of these met the criteria for process occurrence, an additional eight processes were observed which failed to meet the specified criteria. The processes which were observed fell into the categories of substitution processes (8), syllable structure processes (2) and

assimilation processes (1). Within the category of substitution processes, those affecting the phonemic contrasts of obstruents were more common than those which effected nasals or approximants.

It is important to note that several phonological processes observed in the present subjects have been reported in the speech of normally developing children, other processes used by the subjects have been reported in children with deviant phonology and still other processes seemed to be unique to the subjects under study. In addition, certain processes used by normally developing children (described in Chapter 3) were not observed in the speech of the subjects of this study, e.g. stopping, fronting.

The average percentage of phonological process occurrence, for the subjects as a group, was low. For example, no process occurred in more than 54% of potential occurrences (Table 8, p. 11 ). However, when the percentage of occurrence of processes was examined for individual subjects, it was evident that some subjects employed certain processes in more than 70% of occurrences. This finding is suggestive of inter- and intra-subject variability with regard to the use of processes.

As expected, all subjects gave evidence of reduced phonetic inventories of English consonants. While the full quota of nasal and approximant consonants were usually present, obstruents, particularly sibilants, were frequently absent. Non-English consonants were used by all subjects, although the nature and extent to which these occurred varied among the subjects. The absence of certain consonants of English and the presence of non-English consonants may implicate impaired oral structure, an issue which receives further attention in a later section of this chapter.

A further important finding arising out of the present study was the observation of heterogeneous performance with regard to phonological

patterning. The results of the phonological process analysis as well as the phonetic inventories and systems of phonemic contrasts revealed that no two subjects behaved alike, thus underlining the fact that it was very difficult to extract group trends.

The severity of the speech sound production patterns also varied among the subjects. Some subjects (SS and CS) displayed phonological patterns which closely resembled those of normally developing children. Other subjects (ChS, TJ, BS, JM, LC and GH) used numerous compensatory articulations (e.g. glottal stops and fricatives, pharyngeal stops and palatal consonants), which seemed to stem from impaired oral structure and function. In these subjects, the compensatory articulations served to reduce the phonemic contrasts of English and resulted in deviant phonological patterns.

The central question arising out of the results summarised above is: Do the subjects of the present study demonstrate phonological disability, and if so, what is the nature of the disorder? The answer to this question hinges on two important factors: the definition of phonological disability and on the relationship between phonetic and phonological aspects of speech sound production. These factors are addressed in depth in the following sections.

#### 11. JUSTIFICATION FOR DESCRIBING CERTAIN ERRORS OF SPEECH SOUND PRODUCTION AS PHONOLOGICAL ERRORS

It is pertinent at this point to return to the continuing controversies which exist regarding the distinction between phonetic (articulatory) and phonological disorders. This distinction depends largely on the conceptualisation or theoretical standpoint of the proponent. As was discussed in Chapter 3, certain researchers (Hodson, 1980; Shriberg and Kwiatkowski, 1982a) have tended to use the term "phonological disorders" in the generic sense. According to these researchers, phonological disorders include speech sound production deviations at all levels of the speech production process;

ranging from the level of underlying representation through phonetic production, regardless of etiology.

Other researchers (Grunwell, 1981; Shelton and McReynolds, 1979) prefer to establish the distinction between articulation and phonological disorders, using the etiology of the speech sound production disorder to make their distinction. As mentioned previously, these researchers define phonological disability as the disorganisation of the sound patterns of the language in the absence of overt structural or neurological impairment of the speech or hearing mechanisms (Grunwell, 1981; Ingram, 1976; Schwartz, 1983; Shelton and McReynolds, 1979). According to this definition, phonological disability, has its etiology in the speaker's inadequate mental representation of words. In contrast, a phonetic disability is considered by this group of researchers as deviant speech sound production which results directly from impairment of the oral mechanism, i.e. errors in the implementation of adequate phonological knowledge at the physical phonetic level (Hewlett, 1985).

Although understanding the etiology of speech sound production disorders provides a useful foundation on which to formulate appropriate diagnostic and evaluation procedures, it is seldom possible to delineate the precise cause of the problem. The practitioner is ultimately concerned with the presenting problem and the most efficient and effective treatment of the disorder. McWilliams et al. (1984) state that "fortunately it is not necessary, even if desirable, to know the unknowable 'precise cause' in order to plan and execute efficient treatment" (p. 250).

The thrust of the present study has been directed towards a description of the speech sound **production** disorders. Although the contribution of etiological factors has not been ignored, the emphasis throughout has been on a description of the errors that exist, rather than their etiology. Thus, the stress has been laid on

the phonemic contrasts that are or are not made, rather than the reasons for their presence or absence.

In view of the fact that the focus of this study lies in the symptomatology of speech sound production, it is suggested that additional definitions are required which distinguish a phonetic from a phonological error at the level of speech output. As defined in Chapter 4, a phonological error refers to a reduction in the contrastive value of two or more potentially contrastive sounds in adult English, and a phonetic error was defined as an error of speech sound production which did not affect the contrastive value of the phonemes of English. The latter included distortions isomorphic with the target sound.

The results of the phonological process analysis for the group and for individuals revealed that the present subjects demonstrated, in addition to phonetic errors, errors which may be described as phonological, in terms of the definitions provided above. It is interesting to note that the following features which characterise some of the errors of the present subjects have also been observed in the speech of phonologically disordered children (delayed and deviant) who do not have an organic component to their disorder (Compton, 1976; Crystal, 1981; Dunn and Davis, 1983; Grunwell, 1981; Ingram, 1976; Leonard et al., 1980; Schwartz et al., 1980).

#### A. Limited range of consonants

The subjects of this study showed restricted phonetic inventories. Consonants involving the alveolar and alveopalatal places of articulation (particularly stops, affricates and fricatives) were conspicuously absent. The subjects used a wide range of non-English consonants, which were produced in the posterior region of the oral cavity, e.g. glottal and pharyngeal stops and palatal stops and fricatives. Because stimulability for target sounds was not assessed, it is not possible to state definitively whether or not the subjects

were capable of correct production of the target sounds on stimulation. As stimulability testing would have provided important and immediate information regarding the phonetic component of the speech disorder, it is felt that omission of this testing constitutes a limitation in this regard, and that future studies should take this aspect of assessment into account.

The reduced phonetic inventories observed in several subjects may lend support to phonetic errors of speech sound production. However, it is interesting to note that non-cleft palate phonologically disordered children also show reduced consonant inventories (Crystal, 1981; Stoel-Gammon and Dunn, 1985). The difference between these children and the present subjects lies in the fact that phonologically impaired children are capable of correct production of target sounds at least in isolation, on stimulation. Irrespective of whether the underlying disorder in the present subjects is the result of structural/physiological or linguistic factors, the restricted range of English consonants had the effect of limiting the number of acceptable phones the subjects had at their disposal to make the required phonemic contrasts of English.

#### B. Restricted use of phonemic contrasts

Evidence for the conclusion that the present subjects show phonological errors is derived from both the phonological process and contrastive analyses. Despite wide individual variation, analysis revealed that most subjects were impaired in their ability to signal the meaning differences between distinct target phonemes.

Since reduction of phonemic contrasts is evidence for phonological disability, it may be enlightening to compare the systems of contrasts found in the present subjects with Grunwell's Profile of Phonological Development (1981) which summarises the development of phonemic contrasts in normal children. (See Chapter 2 for the portion of this profile relevant to the age of the present subjects).

When the phonemic contrasts demonstrated by the present subjects are examined in relation to those of normally developing children, degrees of phonological delay and phonological deviance are observed. By age 4,6 years, normally developing children should have acquired the full complement of contrastive phonemes (Grunwell, 1982). Only two of the present subjects (CS and SS) achieved Stage VI (equivalent to 3,6 - 4,6 years) on this profile, showing that they were slightly delayed phonologically. The other six subjects showed a mixed picture of delayed and deviant systems of contrastive phonemes. These subjects displayed variable production of the target sounds which led to unstable phonemic contrasts at the output level. Furthermore, these six subjects showed different sets of contrasts at different places in the phonological structure. i.e. more phonemic contrasts were realised in syllable initial than in syllable final position, thus rendering the systems of contrasts asymmetrical.

In some cases, the merged contrast was expressed by means of a recognised English phoneme. For example, as a result of the process of liquid simplification, liquids were replaced by the English glides /w/ or /j/; as a result of non-sibilant replacement, sibilant consonants were replaced by the non-sibilant consonants /θ/ or /k/. In other cases, however, non-English consonants were used. Even though these may be regarded as distortions of English consonants, their effect was to reduce the contrastive values of a class of sounds. For example, the process of palatalisation resulted in the replacement of palatal fricatives /ç, ʃ/ for the alveolar and alveopalatal fricatives /s, z, ʃ, and ʒ/. Therefore, "shower" and "sour" were produced as [çəʊwə], thus merging the contrasts between alveolar and alveopalatal place of articulation. Similarly, in glottal replacement, glottal stops (which McWilliams et al., 1984 consider to be distortions of stops) were substituted for all obstruent sounds, so that "chair", "bear", "tear", "care" and "share" were all produced as [tʰe].



The presence of homonymous forms resulting from the application of phonological processes lends support to the proposal that some of the errors observed in the present subjects could be described as phonological errors. In addition, certain subjects showed patterns of phonological delay and others gave evidence of phonological deviance with regard to the nature of phonemic contrasts they were able to make.

C. Persistent use of phonological processes beyond the expected stage in normal phonological development

The age at which phonological processes are suppressed in normal phonological development has not yet received unequivocal support. In Table 18 below, the phonological processes observed in the speech samples of the present subjects are categorised in terms of normal phonological development, phonological delay and phonological deviance. This table was constructed by the writer on the basis of preliminary normative data presented in the clinical phonology literature (Grunwell, 1982; Hodson and Paden, 1981; Ingram, 1981; Khan et al., 1983; Shriberg and Kwiatkowski, 1980; Stoel-Gammon and Dunn, 1985).

Table 18: Categorisation of the phonological processes observed in the present subjects in terms of normal phonological development, phonological delay and phonological deviance

NORMAL PHONOLOGICAL DEVELOPMENT	PHONOLOGICAL DELAY	PHONOLOGICAL DEVIANCE
Liquid Simplification	Devoicing of final consonants	Non-sibilant replacement
Deaffrication	Cluster reduction	Palatalisation
Labialisation	Final consonant deletion	Velarisation
	Assimilation processes	Glottal replacement

Table 18 above shows that three phonological processes observed in the speech of the present subjects are characteristic of normal phonological development. In other words, they are frequently reported to occur in normal children up to five years of age (Grunwell, 1982). Therefore, with respect to the contrasts affected by these phonological processes, it appears that the present subjects are following the normal developmental schedule.

The processes of final consonant deletion, cluster reduction, devoicing of final consonants and assimilation processes, as they occurred in the present subjects, were categorised as evidence for phonological delay as they are absent in the speech of normal four year old children (Grunwell, 1982; Stoel-Gammon and Dunn, 1985). However, with the exception of devoicing of final consonants, the percentage frequency of occurrence of these processes was low, i.e. less than 40% occurrence. Therefore, although these processes are typical of children with phonological delay, this statement can only be made, bearing in mind their low frequency of occurrence.

#### D. Use of unique processes

The presence of unusual processes not commonly observed in normally developing children provides evidence for phonological deviance, since they imply an unusual pattern of phonological acquisition (Grunwell, 1982). In Table 18 above, it can be seen that four processes have been categorised as phonologically deviant, or unusual. Of these processes, palatalisation, velarisation and glottal replacement have been observed in the speech of non-cleft palate phonologically disordered children (Dunn and Davis, 1983; Edwards, 1983; Grunwell, 1981; Hodson and Paden, 1981; Ingram, 1976; Weiner, 1979). To the writer's knowledge the process of non-sibilant replacement, as defined in the present study, has not been reported in the speech of phonologically normal or non-cleft palate phonologically impaired subjects. However, frequent reports have been published which indicate that phonologically impaired children

experience difficulty in both the articulation and signalling of the phonemic contrasts of strident fricatives and affricates (Hodson, 1980; Hodson and Paden, 1981; Ingram et al., 1978; Ingram et al., 1980).

Based on the present sample, it is possible that three phonological processes (glottal replacement, palatalisation and non-sibilant replacement) may be peculiar to children with cleft palate, especially with regard to the manner in which these processes were applied. These processes, particularly glottal replacement and palatalisation, differed in the present subjects from their application in non-cleft palate phonologically disordered children, in that they collapsed several contrasts. For example, glottal replacement has been defined as the replacement of intervocalic or word final voiceless stop consonants by a glottal stop (Weiner, 1979). In the present study, the replacement of obstruents by the glottal fricative /h/ (as occurred in subject JM) was also identified as an instance of glottal replacement. Similarly, the process of palatalisation refers to the replacement of alveolar fricatives by alveopalatal fricatives (Hodson, 1980). In this study, palatalisation referred to the replacement of alveolar and alveopalatal stops, fricatives and affricates by non-English palatal consonants. Like the other two processes, non-sibilant replacement also affected the contrasts of a wide range of phonemes. Thus, it seemed that when these processes occurred in the present subjects, they were used more extensively than those which have been reported in the speech of phonologically deviant children. The broad application of these processes had devastating effects on intelligibility because of the increase in the number of homonymous forms.

It is important to stress that the suggestion that the above three processes may be unique to children with cleft palate, is tentative and is based on speech production data in only a few children.

Further research is required to verify these observations. Comparison of the results of the phonological process analysis found in this study with those observed in previous studies using this approach in cleft palate children is limited for two reasons. Firstly, as cited in Chapter 3, only two such studies (Hodson et al., 1983; Lynch et al., 1983) have been published, and these have employed single case studies, limiting the generalisability of the findings. Secondly, the high degree of individual variation in subject performance makes it difficult to extract group trends. Nevertheless, the results of the two reported studies revealed high frequency of glottal replacement, backing processes, cluster reduction and final consonant deletion which were also observed in the subjects of the present study. It is clear from the findings of this study as well as those of the abovementioned studies that further research is needed to determine whether cleft palate children do, indeed, show different or perhaps unique, patterns of phonological development in comparison with normally developing non-cleft palate children.

One may conclude from the foregoing discussion of the features of speech sound production patterns, that the present subjects behaved phonologically in that they were unable to contrast the phonemes of English, particularly those involving place and manner of articulation. In some cases the reduction in phonemic contrasts reflected patterns of phonological delay whereas in other cases, unusual phonological patterns were identified, indicative of phonological deviance.

### III. THE POSSIBLE ROLE OF IMPAIRED ORAL STRUCTURE AND FUNCTION IN PHONOLOGICAL ERRORS

The discussion thus far has centred upon the symptomatology of speech sound production errors as they have presented themselves at the phonetic level. However, by virtue of the fact that an organically impaired population was deliberately chosen, some consideration must

be given to the possible role which defective oral structure and function may play in the speech sound production patterns observed in the present subjects.

As was mentioned above, the results of the present study have clearly shown that the subjects behaved phonologically in that they showed a reduction in their ability to make the phonemic contrasts of English distinct from one another. Although it is not possible to state categorically the cause of disordered speech sound production in these subjects, it is speculated that the underlying disorder is mainly phonetic (the result of impaired oral structure and function). It is stressed that this suggestion must be made with caution. The writer was aware that it was important to assess the subjects' underlying phonological knowledge to ascertain their perception of the adult phonemic contrasts. As described in Chapter 5, an attempt was made to assess phonemic perception, but as this testing had limitations, no definitive conclusions could be drawn.

It is postulated that, in this structurally impaired population, the phonological processes and reduction in phonemic contrasts were motivated by lower level phonetic constraints. This view supports that of Hewlett (1985) who suggests, in relation to children with normal oral structure and function, that the child's phonology is responding appropriately to constraints imposed by immature physiology and motor control. Hewlett extends his argument to children with cleft palate and proposes that "such pronunciations as tea [2i] may not be the result of phonological problems, but the responses of an unimpaired phonology in seeking to circumvent problems in production" (p. 164). In certain respects, this view is consistent with Stampe's (1979) definition of a phonological process which refers to a simplification of the adult target presenting "a specific common difficulty to the speech capacity of the individual" (p. 1, cited by Grunwell, 1982, p. 165). In the child with a cleft

palate, his "speech capacity" is not only immature, but also impaired, perhaps resulting in a stronger need, than that of normal children, to simplify phonetically complex adult phonemic contrasts.

The findings of the present research support this viewpoint: with the exception of assimilation processes (which seldom occurred in the present subjects) and labialisation (considered developmentally normal), the remaining phonological processes used by the subjects can be classified as weakening processes. As defined by Edwards and Shriberg (1983) weakening processes are those which take "a segment one step (or more) closer to zero (deletion) (p. 103). Examination of the phonological processes used in the present subjects reveals that target obstruents were either deleted (cluster reduction, final consonant deletion) replaced by a phone produced in the posterior region of the mouth (palatalisation, velarisation), replaced by consonants requiring reduced intra-oral air pressure (deaffrication, non-sibilant replacement, glottal replacement) or were devoiced in word final position (devoicing of final consonants). All of these replacement phones were characteristic of weakening processes (Hyman, 1975, cited by Edwards and Shriberg, 1983). It is possible that processes such as stopping and fronting, commonly described in the speech of children with normal phonological development did not occur as these processes are strengthening processes and require the use of high intra-oral air pressure for their realisation. Thus, the weakening processes may not be the result of weakening processes in the phonological sense, although they appear that way. Inadequate velopharyngeal function and impaired articulatory structures may contribute to disordered speech production to a greater degree than a phonological disorder at the cognitive, psycholinguistic level.

The proposal that impaired oral structure and function could have been responsible for the reduction in phonemic contrasts in the present subjects does not exclude the possibility of co-existing phonological impairment arising from faulty learning patterns or

phonetic deviance per se. For example, BS showed patterns of phonetic disability in that velar stops were frequently replaced by uvular or pharyngeal stops. This change was considered phonetic as the uvular and pharyngeal places of articulation are not phonemic in English and the use of these substitutions did not alter the meaning value of the target phoneme. BS also displayed patterns consistent with phonological delay as was reflected in her use of cluster reduction and liquid simplification, and patterns of phonological deviance as was evident in the frequent use of velarisation and in the variability in the realisation of the phonemic contrasts of adult English (see Chapter 7).

In summary, it is speculated that impaired oral structure and function hamper accurate speech sound production and that the phonology, in turn, accommodates these deviations by merging certain adult phonemic contrasts at the level of speech sound output. Of course, in depth testing is required to determine whether, in addition to disorders of phonetic origin, disorders of speech sound production exist which reflect problems at the more abstract level of underlying representation in children with cleft palate.

#### IV. POSSIBLE FACTORS ACCOUNTING FOR HETEROGENEITY OF FINDINGS

Inter-subject variability in phonological patterning has pervaded the discussion of the findings of this study. Several factors may be responsible for the heterogeneity of the findings, perhaps the most important of which are:

- A. Variability in the structural and functional characteristics of the subjects' oral mechanisms and
- B. Individual variation in patterns of phonological development.

##### A. Variability in oral structure and function

The composition of the subject sample was structurally heterogeneous in that the extent of the subjects' original clefts varied from complete bilateral clefts of the lip, hard and soft palates to

incomplete clefts of the soft palate only. The aim of the present study was not to examine the phonological patterning in children with a particular type of cleft, but to find out about phonological patterning in a heterogeneous group of four year old cleft palate children. Examination of the oral structural mechanisms (Table 5), even though subjective in nature, revealed that certain subjects showed marked velopharyngeal incompetence, in contrast to others who showed relatively unimpaired velopharyngeal function. Furthermore, the subjects displayed varying degrees of dental and occlusal deviations and varying proficiency for rapid repetitive articulation. The role of previous episodes of middle ear disease, and concomitant fluctuating conductive hearing loss also cannot be discounted in a consideration of variability in speech production patterns. While the effects of intermittent hearing loss on speech acquisition has not been firmly established (as discussed in Chapter 2), it is possible that this too contributed to a greater or lesser degree to individual subject's speech sound production patterns.

It is hypothesized that the combined interaction of the factors which relate to impaired structure and function, rather than any single factor in isolation contributed considerably to the overall differences in speech sound production.

#### B. Individual variation in phonological acquisition

The observed inter-subject differences in speech sound production skills of the present subjects may also be accounted for by individual variation in patterns of phonological acquisition. There has been growing recognition among researchers that in addition to several universal and common features of developing phonology, there is abundant evidence to suggest that all children differ widely in their acquisition of the phonology of their language (Bernthal and Bankson, 1984; Ferguson and Farwell, 1975; Grunwell, 1979; Ingram, 1976; Leonard et al., 1980; Stoel-Gammon and Dunn, 1985). Bernthal



and Bankson (1984) state that "individual variation during phonological acquisition should be expected because it is unlikely that all children would derive identical phonological systems during the developmental period" (p. 118).

Individual variation characterises both normally developing and phonologically disordered children (Grunwell, 1979). Since cleft palate children obviously must acquire the sound systems of their language, it would seem logical to infer that at least the same wide range of individual variation would apply in this population. The findings of the phonological analyses for individual subjects revealed differences in the nature of phonological processes observed, their frequency of occurrence, as well as their systems of contrasts. In addition, certain subjects seemed to show more patterns indicative of phonological delay than deviance, while others showed more processes typical of phonological deviance than delay. Still other subjects showed a combination of phonological deviance, phonological delay and phonetic errors.

The phonological patterns displayed by the present subjects underline the inaccuracy of the term "cleft palate speech". In the cleft palate literature of the 1950's and early 1960's, researchers were concerned with extracting group trends in speech sound production and paid little attention to individual differences. This led to the concept of "typical cleft palate speech" which was the short hand phrase to denote hypernasal resonance, audible nasal emission and even the compensatory articulations of glottal stops and pharyngeal fricatives. More recently, this term has fallen into disrepute and the highly heterogeneous character of the cleft palate population with regard to speech characteristics has been recognised (Bzoch, 1979; McWilliams et al., 1984; Moller et al., 1983; Priestersbach et al., 1964). The heterogeneity of the cleft palate population with regard to patterns of phonological functioning is clearly shown in the present study.

Other factors which may have contributed to the heterogeneity of the findings include the history of previous speech therapy, psychosocial factors, subtle differences in learning ability, among others. However, because these factors did not receive direct attention in the present study and were not controlled for, their precise influence on the variability of the phonological patterns observed cannot be established.

The point to be made by this discussion is that the speech sound production characteristics of the children studied varied widely and that heterogeneity was intrinsic to this sample.

#### V. GENERALISABILITY OF FINDINGS

The fact that no two of the subjects studied showed identical phonological patterns indicates that at least for this sample, few generalisations concerning phonological processes in cleft palate four year olds are possible. What did emerge from the findings however was that all subjects showed some processes common in normally developing children and most subjects showed processes consistent with those of phonologically delayed children.

It therefore seems safe to suggest that normal and delayed phonological processes can exist in four year old cleft palate children. However, further research is needed to confirm these findings and to ascertain more directly how impaired oral structure and function affect the phonological functioning of children with cleft palate. Moreover, with additional research, it may be possible to define sub-groups of cleft palate children with regard to the phonological processes used.

VI. CLINICAL APPLICABILITY OF PHONOLOGICAL PROCESS ANALYSIS TO THE  
DESCRIPTION OF DISORDERED SPEECH SOUND PRODUCTION IN CHILDREN  
WITH CLEFT PALATE

The present investigation has shown that certain of the speech sound production disorders in the subjects studied could be described in terms of phonological processes. To this extent phonological process analysis represents a significant improvement over the traditional framework of analysis of "cleft palate speech" which identifies individual errors of articulation. Process analysis provides a more comprehensive than the traditional approach because it seeks to determine patterns in the errors of pronunciation, taking into account both the structural and systemic simplifications used by the child (Grunwell, 1981; 1982).

Although the usefulness of phonological process analysis has been demonstrated in this study, it must be pointed out that it is essentially an error analysis which relates the child's realisation of a target sound to the adult standard form. In Grunwell's (1981) terms:

*phonological processes are in fact generalised comparisons between the patterns in the adult pronunciations and in the child's realisation. They are therefore only an indirect description of the two independent phonological systems that govern the patterning internal to the two sets of data (p. 129).*

Because phonological processes describe errors of production, the resulting patterns are selective; in other words, they do not provide a comprehensive appraisal of the speaker's phonological system as a whole. It is not clear from the results of the phonological process analysis alone, which phonemic contrasts the child is able to signal and in which syllable contexts. Therefore, there is a need for further analysis which takes into account the speaker's contrastive abilities in addition to his contrastive failures.

The phonological processes commonly observed identified in normally developing children did not always describe the errors observed in

the subjects of the present study. For example, there was no set process to describe the replacement of sibilant consonants by non-sibilant consonants. The implication is that clinicians should employ an open set of processes in order to describe idiosyncratic processes, a view endorsed by Edwards (1982) and Ingram (1981).

Phonological process analysis of the speech production data in this investigation did not account for the fact that subjects produced the same target sounds in different ways, i.e. variability of speech sound production. This was particularly true for substitution processes. The relative ease with which a given error can be described in terms of a phonological process does not necessarily capture the effects of variability in speech sound production on the adequacy of the phonological system as a whole. This re-emphasizes the need for contrastive assessment.

Thus although phonological process analysis was a useful tool for describing disordered speech sound production in the present subjects, its application in other cleft palate children should be made with full awareness of its purposes and limitations, i.e. as an analysis to determine the systematic patterns in **errors** of speech sound production. This caveat is issued in the light of the increasing popularity of this form of analysis for a wide range of speech disordered populations. As has been demonstrated in the present research, while certain errors of the subject's speech sound production disorders could be described in terms of phonological processes, others could not. The indiscriminate use of phonological processes to describe all misarticulations in some of the recently published studies in the literature has led to skepticism. McReynolds and Elbert (1981) in referring to children with functional articulation disorders charge that unless phonological processes can be empirically demonstrated, "this kind of analysis is no more than a relabelling of articulation errors" (p. 197). This claim seems

equally applicable to the analysis of disordered speech in children with cleft palate.

VII. SUMMARY

This chapter has attempted to view some of the findings within the framework of clinical phonology. Consideration has also been given to the possible role which structural deviations may contribute to impaired phonology in these cleft palate subjects. In view of the heterogeneity of the findings, their generalisability is limited. The applicability of phonological process analysis to the description of disordered speech sound production in the present subjects received attention. The clinical implications of the results of this investigation are discussed in the concluding chapter.

CHAPTER 9

CONCLUSION

There has been growing awareness of the need to discover underlying patterns in disordered speech production in unintelligible children with functional articulation disorders. This has resulted in the application of the principles of phonological analysis to the description of the speech sound production disorders of these children. In particular, phonological process analysis has gained increasing popularity and has become an attractive alternative to traditional methods of assessment of disordered speech sound production.

The paucity of data on phonological patterns of cleft palate children has motivated the present study. Using phonological process analysis, this study aimed at describing the speech sound production errors of eight four year old children with repaired cleft palates.

In contrast to the widely held opinion that speech sound disorders in children with cleft palate are only phonetic in nature, the results of the present study indicate that the subjects behaved phonologically in that they were unable to signal certain English phonemic contrasts at the level of speech output. This finding has important implications for therapy and diagnosis for a child with a cleft palate.

The most obvious therapeutic implication of reduced systems of contrasts is to introduce new contrasts into the child's speech sound production system to enable him to signal the meaning differences of the adult target and to improve his communicative effectiveness. Since phonological processes, by definition, result in a loss of phonological contrast, expanding the system of contrasts and suppression of delayed or deviant processes may form the simultaneous focus of the remediation programme. It cannot be denied that

traditional methods of articulation therapy may be needed to teach the correct movement patterns required to produce the sounds to be expressed by the contrast. This is particularly relevant in a child whose phonetic repertoire does not contain the target sounds. However, in this case, it is recommended that the child be taught the target sound in isolation and that this should then be incorporated into his phonological system through meaningful use of speech.

In order to achieve expansion of the system of phonemic contrasts, some of the phonologically-based techniques currently employed with non-cleft speech disordered children may be applied to children with cleft palate, e.g. the method of meaningful minimal contrasts (Fokes, 1982) and homonymy confrontation (Weiner, 1981). These procedures emphasize the communicative function of phonology by increasing his or her communicative effectiveness or failure through the use of meaningful contrast. For example, a child with a cleft palate may show a high percentage of occurrence of glottal replacement in which all obstruents are replaced by the glottal stop [ʔ]. Thus, he produces [b1ʔ] for the minimally different words "bead", "beat", "beak" and "bees", "beef", "beach" but demonstrates correct production of /d/, /t/, /k/, /z/, /f/ and /v/ on stimulation. In order to expand the phonemic contrasts in syllable final position, a set of pictures depicting each of the target sounds is presented to the child. The clinician may then instruct the child to request each picture she has in her hand. Because the child uses one homonymous form for all the stimulus words, he will soon learn that he is not getting his message across and that he needs to make some modification to his production in order to do so. This approach facilitates the establishment of the phonemic distinction in a meaningful and systematic manner. Even if the target phoneme is not perfectly correct, but is held distinctive from the other targets, his communicative effectiveness or intelligibility will be increased.

The selection of phonological processes to be eliminated may depend on factors such as frequency of phonological process occurrence, variability of process occurrence, current knowledge of the sequence of process suppression in normal phonological development, or the presence of unusual or deviant phonological processes (Grunwell, 1983b). Several authors have suggested that the starting point in therapy is to eliminate those processes which contribute the most to unintelligibility or those which are suppressed early on in normal phonological development (Grunwell, 1983b; Hodson and Paden, 1983; Ingram, 1976; Stoel-Gammon and Dunn, 1985).

The critical difference between the phonological approach to therapy described above and traditional methods of remediation for cleft palate children lies in the fact that the former deals with patterns of errors in the context of meaningful speech, while the latter aims to achieve correct production of a single consonant in several phonetic contexts containing the target sound. According to Grunwell (1983b),

the fundamental premise of phonological therapy must surely be that the changes in speech production need to take place not so much in the mouth but in the mind of the child. The aim of treatment is to effect cognitive reorganisation rather than articulatory changes<sup>4</sup> (p. 4).

Perhaps this premise needs to be adjusted slightly in its application to children with cleft palate. As stated above, it is not uncommon to encounter a cleft palate child who is physically incapable of correct production of a particular group of sounds. Thus, the premise on which phonological therapy in cleft palate children should be based is, perhaps rather, that changes in speech production need to take place in the mind and in the mouth. This point leads directly into a further important treatment aspect which will determine the effectiveness of treatment, i.e. the notion of phonemic perception.

In the present study, the limitations of the phonemic perception testing procedure used precluded definitive conclusions regarding the subject's ability to discriminate the phonological contrasts on a



perceptual level. In order to find out if the problem does, indeed lie in the speaker's "mind", it is recommended that assessment of phonemic perception is conducted. However, given the difficulties which were made manifest when phonemic perception testing was attempted, additional research is required to develop an appropriate assessment procedure which takes account of the distorted speech sound production in children with cleft palate.

The present study has revealed that phonological process analysis, when used alone, has both advantages and limitations in the description of the speech sound production errors of children with cleft palate. This has important clinical implications in the diagnostic situation. Because phonological process analysis is an error analysis it seems essential that this procedure should form one component of the phonological analysis battery. In view of the high probability of co-existing phonetic and phonological disability, as was demonstrated by the findings of the present research, a phonological analysis battery should be developed which takes both aspects of speech production into account. The following suggestions are made for the assessment of disordered speech sound production in children with cleft palate:

a. The first step, almost too obvious to state, is to ensure that the structural and functional status of the child's oral speech apparatus is capable of adequate speech production. It is obvious that a comprehensive assessment of the oral mechanism for speech production and decisions for further surgical and/or orthodontic management would precede enrolling any cleft palate child for speech therapy. Furthermore, a description of the child's oral structure and function will form a basis on which to relate findings from the analysis of speech sound production.

b. The second phase, assessment of stimulability, relates to the first in that it concerns a measure of the child's phonetic ability. Data from a child who is unable to produce the target sound on

stimulation provide important clues for therapy. In such a case, it is necessary for the initial stages of intervention to focus on correct production of the target sound or class of sounds. Only then can the error sound/s be contrasted with the target sound/s in meaningful approach. In contrast, a child who is capable of correct production of his error sounds may progress favourably with a phonological approach to therapy. In this case, the clinician will aim to expand the child's system of phonemic contrasts, without having to teach correct phonetic production.

c. With regard to the analysis procedure, it seems important to be constantly aware of the possibility of phonological as well as phonetic dimensions in the child's speech problems. Thus, the focus should not be concerned entirely with the phonetic aspects of speech production in the cleft palate child, as has been the trend in the past.

d. The analysis procedure employed should be comprehensive and should examine the data both with regard to patterns of errors as well as the child's ability to produce sounds correctly. With regard to the former, the analysis should not be restricted to the identification of predetermined patterns of errors, instead an open ended approach should be adopted.

e. In addition to the focus on the segmental aspects of speech production, the analysis should also examine the child's phonotactic constraints in a formal manner, i.e. the child's use of target syllable shapes. In the present study, this was unnecessary as the subjects maintained the appropriate syllable shapes. However, in younger cleft palate children such an analysis may be useful in determining the priorities for therapy. For example, without final consonants, therapeutic strategies to teach word final voicing would be impossible.

f. As stated above, a procedure should be employed which will assess the child's ability to discriminate intra-personally his

errors from the target phonemes on a perceptual level. This will enable the clinician to locate the site of the disorder, as either cognitive (in the mind) or phonetic (in the mouth).

The findings of the present study have demonstrated the importance of the need for clinicians to be aware of the phonological and the phonetic components of speech sound production. The detailed findings of the present study in terms of phonological process occurrence must be regarded as preliminary. In order to expand current knowledge of phonological patterns and phonological development of children with cleft palate, further research is indicated. The following suggestions for additional study are made in the light of the findings of the present investigation.

The phonological analyses in the present study were confined to data obtained from speech production samples. Although a test of phonemic perception was administered, the findings could not be analysed as it was felt that the results were not valid. However, a study to determine the relationship between phonemic perception and phonemic production in cleft palate children would yield valuable insights for remediation planning. For example, a child who is unable to perceive the phonemic distinction between independent phonemes or classes of phonemes would require a different therapeutic orientation from a child who could readily perceive such distinctions but could not use these phonemes contrastively. This is particularly relevant in the cleft palate population in view of the possible effects which frequent bouts of middle ear pathology and hearing loss may have on phonological development. Because of the inaccessibility of phonemic perception to systematic investigation, numerous methodological problems such as those encountered in the present study, would require resolution.

The age range of the subjects on whom phonological analysis is conducted could be varied in future studies. Very little is known

about early phonological development in cleft palate children, i.e. children who are in the process of acquiring their first words. As undesirable compensatory patterns of articulation (such as velar palatal obstruents, glottal stops and pharyngeal consonants) are known to develop in some cases even before primary surgical repair of the palate is completed (O'Gara and Logemann, 1983), it may be interesting to investigate their role in the early lexical development of cleft palate children. According to Ferguson (1978) and Ingram (1975), normal children are subject to production constraints in the pre-linguistic periods, e.g. fricatives and consonant clusters are rarely heard in babbling. These production constraints are also apparent in early lexical development. The child may select a few word shapes while avoiding others, depending on the structural characteristics of the words and sound segments contained therein. The additional production constraints imposed by the cleft may result in different word selection patterns from those observed in normals. Empirical confirmation of this hypothesis, may provide the clinician with valuable pointers for language stimulation programmes which may in turn be helpful in predicting subsequent disordered patterns of speech production.

Larger subject samples than those employed in the present study, could be investigated at several age intervals. Such research could aim to determine whether sub-groups of cleft palate children exist with regard to phonological process usage at different ages and how these subgroups relate to current knowledge of normal as well as deviant phonological development.

Longitudinal data, although often practically difficult to secure, are a potential source of valuable information which has both theoretical and clinical implications. A wide range of individual variation in the phonological systems of individual subjects has been demonstrated in the present study. It would be interesting to follow the paths of phonological acquisition of individual children with

varying severity of the original cleft, age at palatal repair and episodes of otitis media along the path of phonological acquisition. Factors such as the rate of phonological acquisition and change, variability in speech sound production as well as phonological alterations in response to surgical intervention and episodes of otitis media could be investigated.

The present study has demonstrated the value in conducting phonological analyses on a subject population in which the underlying basis for the speech sound production disorder is organic. In this regard a final research implication may be to perform similar analyses on patients with other organically related disorders, such as children with cerebral palsy or developmental or acquired apraxia. In these populations, it may be possible to determine unique patterns in reduction of phonemic contrasts which in turn provide helpful clinical insights.

The findings of the present research raise some of the multitude of important questions which must be answered about the relationship between impaired oral structure and function and its effects on the phonological and phonetic aspects of speech production. In order to answer these questions, it is necessary for clinicians and researchers in the field of cleft palate habilitation to adopt an open-minded approach to the description and explanation of the speech behaviours observed. The following statement by Locke (1983), who discusses this issue in relation to clinical phonology, seems equally appropriate to disordered speech sound production in children with cleft palate:

Now that we know techniques for investigating children and for analyzing children's speech it would be desirable to ask why this child is exhibiting that phonetic behavior. And in asking such questions, perhaps we should follow the empirical trail - whether it leads us into cognitive or physiological domains - and quit deciding in advance where it is we want to go (Locke, 1983a, p. 341).

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APPENDIX A

Sample of case history information form completed by the mother  
of each subject prior to experimental testing

CASE HISTORY INFORMATION

NAME: .....

ADDRESS: .....

DATE OF BIRTH:..... TELEPHONE: (H).....

AGE OF CHILD: YEARS.....MONTHS..... (W).....

NAME OF SPEECH THERAPIST:.....

TELEPHONE:..... ADDRESS:.....

FOR HOW LONG HAS YOUR CHILD RECEIVED SPEECH THERAPY?.....

HOW OFTEN DOES YOUR CHILD ATTEND SPEECH THERAPY?.....

EXTENT OF CLEFT AT BIRTH:

CLEFT LIP: YES/NO  
IF YES, WHICH SIDE? LEFT.....RIGHT.....  
BOTH.....

WAS THE GUM (ALVEOLAR PROCESS) INVOLVED ? YES/NO  
IF YES, WHICH SIDE? LEFT.....RIGHT.....  
BOTH.....

CLEFT PALATE: HARD AND SOFT PALATE - YES/NO  
SOFT PALATE ONLY (ie. hard palate intact) - YES/NO  
SOFT PALATE EXTENDING PARTIALLY INTO HARD - YES/NO

HARD PALATE: WIDTH - Narrow.....Medium.....

(If possible, please supply information according to the surgeon's opinion)

SOFT PALATE: WIDTH - Narrow.....Medium.....  
Wide.....

DEVELOPMENTAL HISTORY:

DID YOUR CHILD HAVE FEEDING PROBLEMS AS AN INFANT? (please describe) ..

AGE AT WHICH MOTOR MILESTONES WERE ACHIEVED - 'sat at .....months

crawled at.....months

walked at .....months

AGE AT WHICH SPEECH MILESTONES WERE ACHIEVED - babbled at.....months

- first words at.....months

- first sentences at..months

DID YOUR CHILD'S TEETH ERUPT NORMALLY? YES/NO IF NO, PLEASE SPECIFY....

SURGICAL HISTORY:

LIP REPAIR: DATE:.....AGE OF CHILD:.....  
 SURGEON:.....  
 LENGTH OF HOSPITALIZATION:.....days  
 COMPLICATIONS: (Specify).....

PALATAL REPAIR:

HARD PALATE DATE:.....AGE OF CHILD:.....  
 SURGEON:.....  
 LENGTH OF HOSPITALIZATION:.....days  
 COMPLICATIONS: (Specify).....

SOFT PALATE DATE:.....AGE OF CHILD:.....  
 SURGEON:.....  
 LENGTH OF HOSPITALIZATION:.....days  
 COMPLICATIONS: (Specify).....

ADDITIONAL SURGERY TO CLEFT (e.g. lip revision, pharyngeal flap, nose operation etc.)  
 DATE:.....AGE OF CHILD:.....  
 SURGEON:.....  
 LENGTH OF HOSPITALIZATION:.....days  
 COMPLICATIONS: (Specify).....

GENERAL SURGICAL PROCEDURES

EAR SURGERY (e.g. grommets, myringotomies etc.)  
 NB. PLEASE SUPPLY INFORMATION ON ALL INSTANCES OF SURGERY.

DATE(S).....  
 AGE OF CHILD AT SURGERY.....  
 SURGEON:.....  
 LENGTH OF HOSPITALIZATION:.....

TONSILLECTOMY &/OR  
 ADENOIDECTOMY

DATE:.....AGE OF CHILD:.....  
 SURGEON:.....

LENGTH OF HOSPITALIZATION:.....days

COMPLICATIONS: (Specify).....

MEDICAL HISTORY

DOES YOUR CHILD HAVE ANY PARTICULAR PROBLEM UNRELATED TO THE CLEFT PALATE  
CONDITION? (Specify).....

DOES YOUR CHILD SUFFER FROM FREQUENT COLDS? YES/NO      HOW OFTEN?.....

DOES YOUR CHILD SUFFER FROM EAR INFECTIONS? YES/NO      HOW OFTEN?.....

HOW LONG DO THE EAR INFECTIONS LAST?.....

HAS YOUR CHILD SHOWN EPISODES OF HEARING LOSS DURING THESE PERIODS?....

IF YES, WOULD YOU DESCRIBE HEARING LOSS AS MILD / MODERATE / SEVERE ?

HOW LONG DOES THE HEARING LOSS LAST?.....

WHAT TREATMENT IS PRESCRIBED?.....

HAS YOUR CHILD'S HEARING BEEN TESTED? YES/NO IF YES, DATES?.....

WHAT WERE THE FINDINGS?.....

ORTHODONTIC HISTORY

DOES YOUR CHILD RECEIVE ORTHODONTIC TREATMENT?.....

DOES YOUR CHILD WEAR A PLATE?.....

WHAT IS THE PURPOSE OF THE PLATE?.....

HAVE YOU NOTICED A CHANGE IN YOUR CHILD'S SPEECH SINCE THE PLATE WAS ACQUIRED?  
(Specify).....

DESCRIPTION OF SPEECH

IS YOUR CHILD EASY TO UNDERSTAND? . YES-NO

IS YOUR CHILD EASY TO UNDERSTAND BY

PARENTS.....YES - NO  
SIBLINGS.....YES - NO  
PEERS.....YES - NO  
TEACHERS.....YES - NO  
UNFAMILIAR PERSONS.....YES - NO

ADDITIONAL INFORMATION:.....



APPENDIX B

An example of the checklist used for the examination of the oral  
speech mechanism

EXAMINATION OF ORAL SPEECH MECHANISM

NAME:.....

FACE

Symmetry of left and right halves \_\_\_\_\_  
Appropriate proportion of face parts \_\_\_\_\_  
Evidence of mid facial collapse \_\_\_\_\_

NOSE

Symmetry of left and right halves \_\_\_\_\_  
Nose flattened on side of cleft \_\_\_\_\_

LIPS

Scarring - faint or obtrusive \_\_\_\_\_  
Paucity or overabundance of tissue \_\_\_\_\_  
Presence of notch in lip \_\_\_\_\_  
Function: lip rounding \_\_\_\_\_  
          pursing \_\_\_\_\_  
          close lips \_\_\_\_\_  
          puff cheeks \_\_\_\_\_  
          bite lower lip \_\_\_\_\_

TEETH

Missing teeth (specify location) \_\_\_\_\_  
Alignment of teeth (wide spaces,  
crooked teeth etc.) \_\_\_\_\_  
Labioverted teeth observed \_\_\_\_\_  
Linguaverted teeth observed \_\_\_\_\_  
Presence of prosthesis \_\_\_\_\_

JAW

Occlusion-maxilla protruded anteriorly \_\_\_\_\_  
          -maxilla retruded posteriorly \_\_\_\_\_  
Bite - cross bite (upper incisors \_\_\_\_\_  
          overlap lower incisors &  
          vice versa simultaneously) \_\_\_\_\_  
      - open bite (upper incisors \_\_\_\_\_  
          do not cover lower incisors) \_\_\_\_\_  
      - overbite (upper incisors \_\_\_\_\_  
          too far anterior relative to \_\_\_\_\_  
          lower incisors) \_\_\_\_\_  
      - underbite (upper incisors \_\_\_\_\_  
          posterior to lower incisors) \_\_\_\_\_

### TONGUE

Size of tongue relative to maxillary arch \_\_\_\_\_  
 Function - elevation \_\_\_\_\_  
           - depression \_\_\_\_\_  
           - protrusion \_\_\_\_\_  
           - lateralization \_\_\_\_\_

### HARD PALATE

Height within normal limits \_\_\_\_\_  
 Width of palatal arch \_\_\_\_\_  
 Presence of oronasal fistulae \_\_\_\_\_  
 Excessive scarring \_\_\_\_\_

### SOFT PALATE

Symmetrical left and right sides \_\_\_\_\_  
 Excessive scarring \_\_\_\_\_  
 Length \_\_\_\_\_  
 Relation of soft palate to depth of pharynx \_\_\_\_\_  
 Function - evidence of movement of soft palate on /a/\* \_\_\_\_\_  
           - vertical movement \_\_\_\_\_

### PHARYNX

Presence of enlarged tonsils \_\_\_\_\_  
 Presence of a post nasal drip \_\_\_\_\_

### DIADICHOKINESIS

/p p p / (16.5/5sec) \_\_\_\_\_  
 /t t t / (17.6/5sec) \_\_\_\_\_  
 /k k k / (16.1/5sec) \_\_\_\_\_  
 /p t k / (13.7/5sec) \_\_\_\_\_

### SUMMARY

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

\* - subjective impressions only.

APPENDIX C

Stimulus items comprising the naming task

aeroplane	mouth
baby	necklace
basket	nest
bath	nose
bed	page
bicycle	pig
blocks	queen
blue	rouge
bridge	scarf
candies	scrub
carrot	shoe
cloud	shower
chair	slide
chicken	smooth
cowboy hat	snake
crayons	soup
crocodile	spider
doll	spoon
dress	spray
door	squirrel
elephant	squeezing
feather	star
finger	stove
fish	straw
flag	swimming pool
flower	television
fork	that
frog	three
fruit	thin
ghost	thumb
gun	toothbrush
glasses	torch
gloves	truck
hanger	vase
horse	vest
icecream	watch
jug	web
jungle gym	yellow
leaf	zebra
light	zip
mask	

## APPENDIX D

Transcription symbols

The following transcription symbols, derived from Moller et al. (1983), PRDS (1980) and Frost (1981), were used in conjunction with those contained in the International Phonetic Alphabet (revised to 1979):

SYMBOL	DESCRIPTION	PHYSIOLOGICAL CORRELATES
PLACE OF ARTICULATION		
[ʕ]	voiceless pharyngeal stop	overall retraction of tongue which articulates with posterior pharyngeal wall
[ɛ]	voiced pharyngeal stop	
[c]	voiceless mid-dorsum palatal stop	tongue contacts mid-palate in the same position as the glide /j/
[ɟ]	voiced mid-dorsum palatal stop	
[ɤ]	voiceless posterior nasal fricative	pharynx constricts as velum approximates the posterior pharyngeal wall. Air is released nasally
SECONDARY ARTICULATION		
[~]	nasalization	sound produced with nasal resonance - usually applies to vowels and approximants
[~]	nasal air emission	noise energy is released nasally - usually applies to consonants
[~]	denasalization	absence of appropriate degree of nasal resonance
[ɸ]	labialized	non-labial consonant is accompanied by lip rounding
[ɸ]	non-labialized	labial consonant is unrounded
[ɰ]	palatalized	secondary raising of tongue toward palatal region
[ɬ]	lateralized	air stream is released laterally as opposed to centrally
[ʔ]	glottalized	sound is produced with secondary closure at the glottis. The oral consonant is released followed by the glottal sound

SYMBOL DESCRIPTION	PHYSIOLOGICAL CORRELATES
<p>STOP RELEASE SYMBOLS</p> <p>[<sup>h</sup>] aspirated</p> <p>[<sup>*</sup>] unaspirated</p> <p>[<sup>ʔ</sup>] unreleased</p> <p>VOICING SYMBOLS</p> <p>[<sub>v</sub>] partially voiced</p> <p>[<sub>Δ</sub>] partially devoiced</p> <p>OTHER SYMBOLS</p> <p>[<sup>w</sup>] weak articulation</p> <p>[:] lengthened articulation</p> <p>( ) silent articulation</p>	<p>can apply to vowels or consonants</p> <p>sound is inaudible but visually observed</p>

Transcribed speech data from the naming task for each subject

GLOSS	TJ	CS	JM	BS	CHS	LC	SS	SH
airplane	ɛɛʔiʔlɛn	ɛi : ʔiɛn	ɛʰmɔɔ	ɛiʔiʔlɛ	ɛwɛʔiʔlɛn	ɛɛʔiʔlɛn	ɛwɛʔiʔlɛn	ʔi : ʔiʔlɛn
baby	bɛʔi	bɛʔi	ʔɛi mi	bɛʔi	bɛʔi mi	ʔɛiʔlɛ	bɛʔi	bɛʔi
basket	ʔɛɔk	bɛʔɛt	bɛ : hɛh	bɛʔkɛk	bɛ : ʔɛʔ	bɛ : ʔɛʔ	bɛ : ʔɛʔ	bɛ : ʔɛʔ
bath	ʔɛ : f	bɛ : ʔ	pɛt	bɛ : f	bɛ : ʔ	bɛ : f	bɛ : f	bɛ : ʔ
bed	ʔɛʔ	bɛd	ʔɛ	pɛc	ʔɛc	ʔɛɛʔd	bɛ : t	bɛd
bicycle	ʔɛʔiʔl	bɛ : ʔiʔl	pɛʔiʔl	ʔɛ : ʔiʔl	bɛʔkɛ	ʔɛʔiʔl	bɛʔkɛ	bɛʔiʔl
blocks	ʔiʔɛʔ	bɛʔkɛ	wɛʔ	ʔiʔk	bɛʔkɛ	ʔɛʔkɛ	bɛʔkɛ	bɛʔkɛ
blue	ʔiʔ :	bɛlɛ :	wɛ :	ʔiʔ :	bɛlɛ :	ʔiʔ :	bɛlɛ :	bɛlɛ :
bridge	ʔiʔɛʔ	bɛʔiʔ	ʔi :	bɛʔiʔ	bɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	bɛʔiʔ
candles	ʔɛʔiʔ	bɛʔiʔ	hɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	bɛʔiʔ
carrot	ʔɛʔiʔ	bɛʔiʔ	hɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	bɛʔiʔ
cloud	ʔɛʔiʔ	bɛʔiʔ	hɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	bɛʔiʔ
chair	ʔɛ :	bɛ :	hɛ	ʔɛ :	bɛ :	ʔɛ :	bɛ :	ʔɛ :
chicken	ʔɛʔiʔ	bɛʔiʔ	hɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	bɛʔiʔ
cowboy hat	ʔɛʔiʔ	bɛʔiʔ	hɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	ʔɛʔiʔ	bɛʔiʔ	bɛʔiʔ



GLOSS	TJ	CS	JM	BS	CMS	LC	SS	GH
gloves	ɣlɔf	ɣlɔf	wɔ	ɣlɔf	ɣlɔf	ɣlɔf	ɣlɔf	ɣlɔf
hanger	hæŋə	hæŋə	hæŋ	hæŋ	hæŋ	hæŋ	hæŋ	hæŋ
horse	wɔ:θ	hɔ:θ	hɔh	hɔ:θ	hɔ:θ	hɔ:θ	hɔ:θ	hɔ:θ
icecream	ɔ:θi:m	ɔ:θi:m	ɔ:θi:m	ɔ:θi:m	ɔ:θi:m	ɔ:θi:m	ɔ:θi:m	ɔ:θi:m
jug	ɣɔ:θ	ɣɔ:θ	hɔ	ɣɔ:θ	ɣɔ:θ	ɣɔ:θ	ɣɔ:θ	ɣɔ:θ
jungle gym	ɣɔ:θ	ɣɔ:θ	hɔ	ɣɔ:θ	ɣɔ:θ	ɣɔ:θ	ɣɔ:θ	ɣɔ:θ
leaf	li:f	li:f	li:f	li:f	li:f	li:f	li:f	li:f
light	la:t	la:t	la:t	la:t	la:t	la:t	la:t	la:t
mask	ma:sk	ma:sk	ma:	ma:sk	ma:sk	ma:sk	ma:sk	ma:sk
mouth	maʊθ	maʊθ	maʊ	maʊθ	maʊθ	maʊθ	maʊθ	maʊθ
necklace	neklaɪs	neklaɪs	neklaɪs	neklaɪs	neklaɪs	neklaɪs	neklaɪs	neklaɪs
nest	neɪs	neɪs	neɪ	neɪs	neɪs	neɪs	neɪs	neɪs
nose	nəʊs	nəʊs	nəʊ	nəʊs	nəʊs	nəʊs	nəʊs	nəʊs
page	pæɪ	pæɪ	pæɪ	pæɪ	pæɪ	pæɪ	pæɪ	pæɪ
pig	pɪg	pɪg	pɪg	pɪg	pɪg	pɪg	pɪg	pɪg
queen	kwi:n	kwi:n	kwi:n	kwi:n	kwi:n	kwi:n	kwi:n	kwi:n
rouge	ru:ʒ	ru:ʒ	ru:	ru:ʒ	ru:ʒ	ru:ʒ	ru:ʒ	ru:ʒ



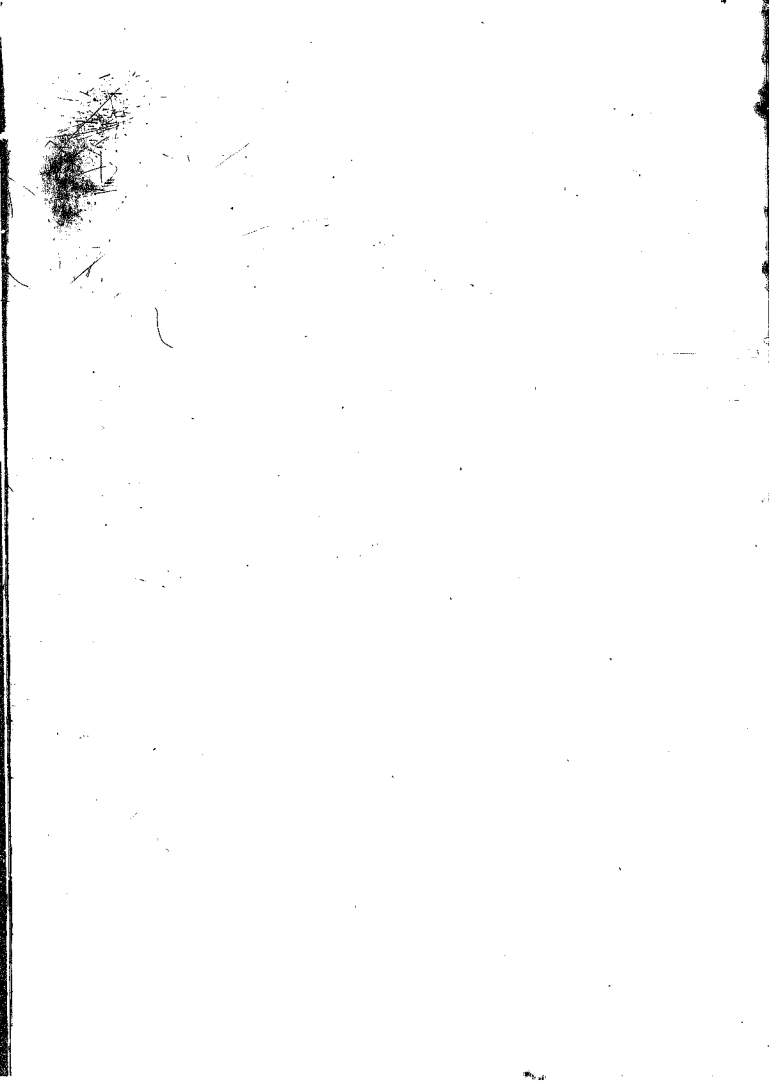
GLOSS	TJ	CS	JM	BS	CNS	LC	SS	GH
scarf	Pa:f	ga:f	ha:f <sup>6</sup>	ʃka:p	ʃka:f	Pa:f <sup>8</sup>	θa:θ	ga:f
scrub	ʔa:p	kɛb	hɛn	Δkɛp	ʃkɛp	ʔwɛb	θwɛp	ʃja:p
shoe	ʔu:	ʃu:	hu:	Δu:	ʃu:	ʔu:	θu:	ʃu:
shower	ʔa:wa	ʃa:wa	həw	Δa:wa	ʃa:wa	ʔa:wa	θa:wa	ʃa:wa
slide	ʔlaɪ?	θlaɪ	hwaɪ	ʃlaɪ	ʃlaɪ(ʃ)	Pa:ɪʃ	θa:ɪ	ʃlaɪ?
smooth	ʔu:f	ʃu:ɪ	mu:	Δu:f	ʃmu:ɪ	ʔmu:f	θmu:ɪ	ʃmu:ɪ
snake	ʔnaɪ?	nəɪk	ʃaɪk	Δnaɪʃ	ʃnaɪk	ʔnaɪk	θnaɪk	ʃnaɪk
soup	ʔu:p	θu:p	hu:p	ʃu:p	ʃu:p	ʔu:p	θu:p	ʃu:p
spider	ʔpaɪʃa	paɪdn	paɪja	ʃpaɪja	ʃpaɪʃa	ʔpaɪʃa	θpaɪʃa	ʃpaɪʃa
spoon	ʔu:	ʃu:n	hū:	ʃpū:n	ʃpū:n	ʔpū:n	θpū:n	ʃpū:n
spray	ʔɪaɪ	paɪɪ	ɪaɪ	ʃpaɪɪ	ʃpaɪɪ	ʔpaɪɪ	θpaɪɪ	ʃpaɪɪ
squirrel	ʔwaɪo	kaɪaɪt	hwaɪo	Δwaɪo	ʃwaɪo	ʔwaɪo	θwaɪo	ʃwaɪo
squeezing	ʔwaɪɪɪ	kwaɪɪɪn	hwaɪɪɪ	ʃwaɪɪɪ	ʃwaɪɪɪ	ʔwaɪɪɪ	θwaɪɪɪ	ʃwaɪɪɪ
star	ʔa:	θa:	ha:	Δa:	ʃa:	ʔa:	θa:	ʃa:
stove	ʔa:ʃ	ʃa:ʃ	həʃ	ʃa:ʃ	ʃa:ʃ	ʔa:ʃ	θa:ʃ	ʃa:ʃ
straw	ʔla:	dɪd	hwa:	Δla:	ʃla:	ʔla:	θla:	ʃla:
swimming pool	ʔwaɪo ʃpū:l	ʃwaɪo pū:l	hwaɪo pū:l	ʃwaɪo pū:l	ʃwaɪo pū:l	ʔwaɪo pū:l	θwaɪo pū:l	ʃwaɪo pū:l



## APPENDIX F

T-values obtained from Wilcoxon Matched Pairs Signed Rank Test indicating significant and non-significant differences between percentage of occurrence of phonological processes in naming and connected speech tasks

	T-values	Significant Difference	Non-Significant Difference
<b>Substitution Processes</b>			
LS	12		x
DEAFF	9.5		x
NON-SIB REP	14		x
LAB	13		x
PAL	16		x
VEL	13.5		x
DFC	2	x	
GR	10.5		x
<b>Syllable structure Processes</b>			
CR	11		x
FCD	5		x



**Author** Goldsmith Tessa Ann

**Name of thesis** Phonological Analysis Of The Speech Of Children With Cleft Palate. 1985

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